NORTH ATLANTIC

MEMOIR.

NORTH
ATLANTIC OCEAN
WINDS
Showing the Limits of the Trade Winds
and
Observed Courses of Rotary Gales
in Aug 1873 thus — & Feb 1870
From Official Reports published by the Meteorological Office
HUDSONS BAY
GREEN LAND
ICELAND
DAVIS STRAIT
Cape Farewell
Hudsons Str
Southampton
Aug 1
Aug 17
Aug 28
Aug 25
Aug 20
Centre of Gale Barometer about 29.5 in
Feb 1870
ANTI-TRADE WINDS
Permanent Area of HIGH Barometrical Pressure Bar 30.2 to 30.5 in
Great Bank
Bermudas
UNITED STATES
CANADA
GULF OF MEXICO
CARIBBEAN SEA
PACIFIC OCEAN
SOUTH AMERICA
Tropic of Cancer
Equator
Tropical Calms
July Aug Sept
May June Oct
Nov Dec Jan Feb Mar April
Hurricane Region
NE TRADE WINDS
SE TRADE WINDS
Limits of Calms
Line a July Aug Sept
b June Oct Nov Dec
c Jan Feb Apr May
d March
Limits of NE Trades thus
North limit of SE Trades
Limits of SW Monsoon
Barometrical Pressure
below 29.9 to 30 in
Aug Sept
July
Mar Apr May June Oct
Nov Dec Jan Feb
MONSOONS AND CALMS
Aug Sept Oct
14 Aug
BAY OF BISCAY
SPAIN
FRANCE
PARIS
NORTH SEA
MEDITERRANEAN SEA
Madeira
Canary Is
Cape Verde Islands
June 21
July 23
Aug 23
Sep 23
May 21
Apr 20
Mar 23
Summer Tropical Sun

X-53165

MEMOIR,

DESCRIPTIVE AND EXPLANATORY,

OF THE

NORTHERN

ATLANTIC OCEAN,

AND COMPRISING

INSTRUCTIONS, GENERAL AND PARTICULAR,

FOR

THE NAVIGATION OF THAT SEA.

FOURTEENTH EDITION.

BY ALEXANDER GEORGE FINDLAY, F.R.G.S.,
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LONDON:
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1879.

"O'ER the glad waters of the dark blue Sea,
Our thoughts as boundless, and our souls as free,
Far as the breeze can bear, the billows foam,
Survey our EMPIRE, and behold our home."

—*Lord Byron.*

ENTERED AT STATIONERS' HALL.

PREFACE

TO THE THIRTEENTH EDITION.

THE present work has been before the Public for more than half a century—a period that has witnessed a total change in the aspect and requirements of Hydrography, as in most other departments of knowledge.

Professing to deal with the subject in its present condition, this Edition bears no resemblance to the Work in its original form, except in the title it bears; every topic and every page have been changed by the gradual or sudden accession of facts which modern history and refinement bring to bear upon every branch of inquiry.

There has been no greater advance made during any portion of the long time that has elapsed since its first appearance, than has taken place during the last twenty years; and to represent that advance this Edition has been entirely remodelled, and may be considered rather as a new Work upon the former arrangement, than as a revised production.

The great distinction between modern progress and that which the various Editions in former years had to record, is, that each branch of Science is now elaborately investigated by Government, and to these labours the painstaking individual can scarcely hope to add anything.

The examination of the bottom of the ocean, almost a new subject, and yet in its infancy, has already dispelled many of those dangers which were formerly believed to exist. The beautiful Lighthouse systems; the various features which have been eliminated in the Wind and Current systems, and their bearings upon the best routes for traversing the Ocean; the more exact acquaintance with the magnetical condition of the Earth, and the most important connection this has with the increasing number of iron ships, with many other subjects, will be duly discussed in the ensuing pages.

To enumerate the authorities to which we are indebted would be to offer a long list: we have duly acknowledged them throughout the work; and we trust that this *Thirteenth Edition* may do good service to the mariner in its quiet utility, as has been done by those which have preceded it.

A. G. FINDLAY.

LONDON, *February*, 1873.

The *Fourteenth Edition* contains a Diagram of the Winds, the Anti-Trade Regions of which recent publications of the Meteorologal Office have enabled us to illustrate for the first time. The Depth of the North Atlantic is also shown by a Chart; this subject having been so fully made known for the first time by the voyage of H.M.S. *Challenger*; on this Chart the positions of the various telegraphic cables are shown. Captain Toynbee's proposed Best Monthly Routes across the Equator have been materially altered, and deserve especial attention. In the body of the book, each section has been carefully gone over, and every available authority utilized for its improvement.

LONDON, *December*, 1878.

ADDENDA.

Winds.—In the illustrative diagram at the commencement of this Volume is shown the routes of areas of low barometrical pressure, around and towards the southern side of which the winds of Atlantic gales have been observed to blow. These are given from Captain Toynbee's works on the Meteoroloy of the North Atlantic for the month of August, 1873, and for the eleven days ending February 8th, 1870.

The gales do not appear to be true revolving storms, such as the tropical hurricanes, for the reason that very few observations for easterly winds are recorded. It may be that these easterly winds would be found to the northward of the ordinary tracks of ships; but, as shown in the diagram, the winds have been observed to blow around the southern side of the centre of low pressure, from the N.W., West, and S.W.

From the area of low pressure (barometer 29·3 to 29 6 inches) to the southern side of these gales (barometer 30 to 30·2 in.) the average observed distance is about 500 miles, speaking very roughly. (*See* ROTARY GALES, in Index, at end of this volume).

The *Cyclone*, August 14th to August 26th, appeared to be broken up on reaching Newfoundland.

The area of high pressure near the Azores is liable to but little variation throughout the year, and the winds blow around, and out of, it *with watch-hands*, thus following the principles of Buys Ballot's Law. In each of the great oceans there appears to be a similar spot, which may be considered an axis around which, not only the winds, but the waters also, revolve.

Best Monthly Routes across the Equator.—By Captain Toynbee's wish we add the following to his remarks:—

"The navigator must remember that it is impossible to lay down fixed tracks for him to follow, because the winds are not always the same at the same time of year. The tracks given on the chart (p. 467) are those which it is probable the wind will permit him to follow. Sometimes he will be able to do better than to strictly follow these tracks; at others he may be driven to do worse. He should not go out of his way to follow them, neither should he be guided by them alone, but by reading the remarks (pp. 467—475), form an independent opinion.

"To the Outward bounder the tracks indicate the best routes for wind, and a safe longitude for crossing the Equator into the region of the S.E. Trades, keeping clear of the coast of South America. To the Homeward bounder they indicate the best routes for wind across the Equator and up to the southern limit of the N.E. Trades."

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THE

NORTH ATLANTIC OCEAN.

SECTION I.

TABLES OF DETERMINED POSITIONS, AND THE AUTHORITIES, THE VARIATION OF THE COMPASS, ETC.

The North Atlantic Ocean is the smallest of all the great divisions of the Ocean, but it has ever been of far greater importance to man than all others collectively. It owes this great maritime superiority to the great proportionate length of its varied coast line, which perhaps nearly equals all other navigable seas, and to the vast area drained by the rivers falling into it, which give ready access and intercommunication to seats of dense and inland population. It is from these causes that the inhabitants of its maritime countries have, in all ages, applied themselves to navigation; and it is more than probable that the facilities thus afforded by it for commerce and travel has caused the nations who inhabit the vicinities of those vast inland seas and bays which distinguish the Atlantic to make greater progress in civilization than those in any other part of the globe.

The area of the North Atlantic does not comprise more than about one-eleventh part of the entire ocean. From its having been the great highway for so many ages, its history, features, and phenomena are better known than any other, and we are now enabled to give a far more perfect view of it—in every aspect—than of the rest of the world of waters.

It may be important in some mercantile questions to define the boundaries of the various divisions of the Ocean, but this has not been authoritively done for the whole of the world.

In 1845, the Royal Geographical Society of London appointed a committee to define the limits of the various oceans; and their report defines:—

"The limits of Arctic and Antarctic Oceans, respectively to be the Arctic and Antarctic Circles; that the limits of the Atlantic on the North and South, be the Arctic and Antarctic Circles; that its western limit be the coast of America, as far South as Cape Horn, and thence prolonged on the meridian of that Cape, until it meets the Antarctic Circle; that its eastern limit be the shores of Europe and Africa, as far South as the Cape of Good Hope, and thence prolonged on the meridian of Cape Agulhas, till that meridian cuts the Antarctic Circle."

Our present work deals exclusively with the northern portion of the area thus defined, or that part which is separated from the southern by the Equator.

The length of the coast lines which bound the North Atlantic and its chief bays, (except the Mediterranean), measured around their principal sinuosities, is not less than 62,000 miles; if more minutely estimated it would amount to much more. A table is given presently, which will show the numbers which make up this sum, and which are relatively equal. Of these coasts about 7,000 miles, or one-ninth, remain unsurveyed; but they are the Arctic regions, unfrequented by commerce. Of the remainder, two-fifths have been surveyed by the British Government, and three-fifths by foreign powers.

The coasts of the Atlantic are now represented with the most minute accuracy in nearly all places of interest to the sailor. The elaborate surveys which have nearly approached completion have been in progress during a greater portion of the present century; and in some cases, as the coasts of Spain, and some parts of our own shores, at the latter part of the last century.

The first portion of this volume consists of a selection of the principal geographical points established in these operations, and appended to them are some notes, which will sufficiently explain their nature. In former editions we were led to discuss the merits of various authorities and the discrepancies between them, which were often considerable in amount; but now these differences have been so removed, and such minute exactness attained, that whatever notes there may be on this topic, must be rather taken as subjects of curiosity than of practical utility.

It is therefore manifestly impossible that the seaman in the ordinary pursuit of his calling can hope to improve what has cost so much labour, and such refined appliances. Almost every point in the geographic tables which follow may be taken as a point of departure by which he may correct his reckoning or rate his chronometer; and the explanatory notes appended will serve to give him confidence, and afford information upon this important section of hydrography.

The first chart of the Atlantic, upon a large scale, was published in Amsterdam by the predecessors in the still existing house of Van Keulen, in the middle of the last century. It was issued under the title of the *Spanish* or *West Indian Sea;* it contained some useful details, amidst a thousand errors. The second, entitled a *Chart of the Atlantic Ocean*, was engraved at London, on the circular projection, invented by Mr. Murdoch, but was found to be extremely inaccurate, and the constructor added to the Archipelago of Cape Verde, two islands, under the names of St. Philip and St. John, neither of which existed; these names being sometimes given by the Portuguese to the Islands Fogo and Brava.

The next, which was the first of the kind published in this country, was constructed by M. de la Rochette, a painstaking and talented hydrographer, in 1777; and was published by the house whence the present work issues, in that year. It was drawn upon the basis of the observations of M. Fleurieu, and for many years was in large demand; of which some degree of proof may arise from its having been during the period repeatedly copied, and illegally published. In the course of time many improvements were obtained, and it was superseded, in 1812, by another of the same scale and size, constructed by Mr. John Purdy, a name well known to mariners for many years. This chart, in its various editions, did good service to seamen for a long

period, and still is deserving of confidence, as representing most of the features requisite, with sufficient accuracy, to ensure the safety of navigation.

These charts in their turn, having required many improvements, from the great acquisition of exact knowledge which characterizes the present day, it was deemed necessary to supersede them by the new charts which have been published by the proprietor of this work, as compiled from the now nearly perfect geographical data. They moreover exhibit, at one view, a summary, in a graphic form, of all that range of phenomena with which hydrography has of late been enriched.

But there is one drawback to the great increase of observation. Each department of hydrography is overloaded for practical every-day use,and the seaman would waste much time in endeavouring to elicit some system from the multifarious authorities he has now before him. A system of mean results has therefore been adopted, as will be hereafter explained, under the various sections which follow.

Hydrography, as at present understood, commenced with Captain Cook, in his celebrated first voyage to the South Seas, in 1768. Previous to this, our coasts were represented and corrected by the rude draughts and imperfect reckonings of pains-taking mariners, in the pursuit of their profession; but the extended practice of lunars, and the use of chronometers, soon made great improvements in geographic representation. Captain Cook, prior to his appointment to the great Exploring Expedition, was employed in surveying portions of the Gulf of St. Lawrence; and the first work which he published was a series of charts of the South and West Coasts of Newfoundland. It is very interesting to know that the great circumnavigator's earliest works have outlived all their contemporaries. His charts, published by the predecessor of the proprietor of this work, are still in demand, and have been till recently the only faithful representations extant.

Our present object is not to give a history of the progress of charts, or we might here present a long catalogue of those worthy observers, who, by patient investigation, and multiplied observation, made the geography of the ocean nearly as good, for the mariner's use, as the far more elaborate public surveys which have superseded them. These last have the exclusive merit of being connected, and each portion placed in exact relation to every other portion—a feature which is owing to the magnificent systems of triangulation, which are now extended over the most important portions of the civilized world. The degree of accuracy, and the extent of these, may be understood, when it is asserted that the whole of the positions hereafter given on the coasts of Europe, between Norway and Spain, do not vary from the *absolute* truth more than a few feet.

It is the defect of detached observations that they do not exactly accord with those by different individuals. It was the discrepancies arising from this source, which necessitated the discussions formerly given on Atlantic geography. But still there is much that was useful in the older works, which is too often forgotten in the multiplicity of detail collected by modern surveyors, which overload as it were the subjects they embrace with too great a mass of knowledge for general use. Toward the end of last century, there were several names which deserve especial mention here, as their works will bear every comparison with those of their more favoured successors. Among these was Murdock Mackenzie, who surveyed a large portion of the western shores of Scotland, and all the coasts in the North of Ireland. Grœme

Spence, an admirable surveyor, surveyed the southern coasts of England, between 1772 and 1812.

The coasts of Spain and Portugal laid down in accordance with the valuable surveys of Tofiño, Franzini, &c., and in the delineation of the African Coasts, with the islands off the same, the positions afforded by Messrs. Fleurieu, Verdun de la Crenne, Borda, Pingré, and Roussin of France, were the authorities for our charts.

The American Coasts were originally exhibited according to the observations and surveys of our illustrious countryman, Captain Cook, as before mentioned; those of Lieutenant Michael Lane, of Mr. Des Barres, of Captain Holland, of Messrs. Wright, Mason, Dixon, and de Mayne, rectified with the observations of Dr. Rittenhouse, Mr. Ellicott, Mr. Hassler, and other astronomers. &c., of the United States.

For the correct delineation of the West India Islands, much of our earlier information was derived from the labours of Messrs. Puysegur, Verdun, Borda, Pingré and other foreign officers, whose names will be for ever entitled to respect. They were the pioneers who were followed by the skilful observers acting under the orders of the Hydrographic Directors of Madrid; particularly the Capts. Joaquin Fr. Fidalgo, Cosme de Churruca, and Jose del Rio; to whom, and to the Baron von Humboldt, Messrs. Oltmanns ,&c., we were indebted for the proximate situations of many points of Spanish America. These have again been adjusted by British Officers.

The numerous surveyors who have seconded these scientific leaders in the completion of our hydrographic representations, will be alluded to in connection with their respective labours hereafter.

While we can refer with confidence to the charts of the various coast lines, as being so perfect, that no possible alteration will be made in the fixed features of the land, that could be rendered applicable upon a general chart, there is one branch that is not so satisfactory. This is the list of detached dangers, as rocks or shoals, which have been from time to time reported, and which, unless disproved, are a constant and daily source of great anxiety to those who have to pass their vicinity. To deal with the conflicting and ambiguous statements recorded, is most perplexing. Still it is most essential that no danger should remain unmarked, although its existence or situation may be involved in great doubt. It is of the utmost importance to the facility and safety of navigation, that these dangers should be correctly placed and characterized, and in the case of a fresh discovery, some test, as by the sounding lead, ought to be applied, to determine its absolute existence. This is now most imperative; without such guarantee, any such announcement is next to worthless, as being authentic, and most mischievous, as leading to distrust and anxiety. All that we know of this subject is recorded in a later part of this work, and in the chart, but it may be stated that of late the extended practice of deep-sea soundings, has actually disproved the existence of many apparently well-authenticated dangers, and thrown very great doubt upon others.

It has been above stated that the length of the coast line of the North Atlantic Ocean, between the Arctic Circle, and the Equator (excluding the Mediterranean), is about 62,000 miles, more or less. This estimate is higher than has been usually attributed, but it is the result of a measurement around the present surveyed coasts, omitting the minor sinuosities and smaller islets. If these were taken into the account the sum would be much greater, as may be supposed, upon an examination, for

example, of the vast range of islets which front the coasts of Norway and Finland, but it is the length of line over which the patient marine surveyor has had to toil in the execution of his arduous but most important duties. These numbers, however, but faintly express, as indeed anything we could say here would fall short of telling, how much has been done to bring the hydrography of this ocean to its present condition. It is enough here to draw the seaman's attention to a few of the results of those costly and laborious surveys which he benefits by.

Of the 62,834 miles of sea coast, the English Government have surveyed about 23,600 miles; foreign governments about 31,600 miles, the remaining being unsurveyed.

Of the coasts of Europe, the English Admiralty and Ordnance have only surveyed about 4,000 miles out of 19,000 miles.

The following Table of the details of the length, &c., of each country, is therefore given rather as a matter of curiosity than material utility, and will form a fitting introduction to the Geographic Tables which follow.

COUNTRY.	SURVEYED BY	DATE OF SURVEY.	Extent of Coast Ge. miles	TOTAL GEO. MILES.
England; South Coast and Channel Islands	British Ordnance and Admiralty.	1792—1852	438	
„ East Coast	„	1830—1859	470	
„ West Coast	„	1772—1860	748	
Scotland; East and North Coasts, and Islands	„	1815—1850	810	
„ West Coast and Ids.	„	1750—1863	400	
Ireland	„	1828—1858	1320	
Total British Isles	.....	.....	..	4236
Norway; West & South Coasts	Dan. & Norw. Gts.	.....	2900	
Denmark; East Coast and Ids.	Danish Govmnt.	.....	1585	
Prussia	Prus. & Dan. Govt.	.....	625	
Russia and Finland	Russ. & Swed. Gt.	.....	2720	
Sweden	Swedish Govmnt.	.....	2360	
Total Baltic, &c.	.....	.....	..	10,190
Denmark; West Coast and Færöe Islands	Danish Govmnt.	1806—1841	..	730
Hanover	Dutch Govment.	.....	..	180
Holland	„	.....	..	540
Belgium	French Govment.	1816—1839	.	64
France	„	„ „	..	1687
Spain (to Gibraltar)	Spanish Govment.	.....	..	915
Portugal	Various	.....	..	540
Total Coasts of Europe	.....	.....	..	19,082
Marocco, &c.	Fr. and Brit. Gts.	1835—1858	460	
Agadir to Equator	British Govment.	1826	4430	
Total Africa	.....	.....	..	4890
Total Atlantic Islands	British Govment.	1783—1846	..	2990
Iceland	Danish Govment.	1845	1500	
Greenland	Not Surveyed	.....	2000	
Hudson's Bay, &c.	„	.....	4000	
Labrador; East Coast	„	.....	1140	
Total Arctic Lands, &c. ..	.....	.....	..	8340

COUNTRY.	SURVEYED BY	DATE OF SURVEY.	Extent of Coast Ge. miles	TOTAL GEO. MILES.
Newfoundland; East and South Coasts	British Govment.	1765—1867	2765	
Gulf of St. Lawrence	„	1766, 1819, 1849	2820	
Cape Breton, Nova Scotia, and New Brunswick	„	1824—1860	1765	
Total British America	.....	.....	..	7350
United States; East Coast	U.S. Government	1817——	3735	
„ „ South Coast ..	„	.....	2070	
Total United States	.....	.....	..	6505
Mexico, and Central America..	Span. & Brit. Gts.	1808	3295	
Colombia and Guayana	Span. Fr. & Brit.	.....	4100	
West India Islands (British) ..	Various	.....	2947	
Haiti and Cuba.....	Not properly Sur.	.....	2350	
Various Islands.....	.....	.....	685	
Total West Indies, &c.	.....	.....	..	13,377

The following shows the general amount, the details of which are given above :—

COUNTRY.	TOTAL GEO. MILES.
EUROPE	19,082
AFRICA.....	4,890
ISLANDS	2,990
AMERICA.....	35,872
TOTAL LENGTH of the Coasts of the North Atlantic Ocean ...	62,834

POSITIONS OF PLACES, ETC.

I. ENGLAND AND WALES.

*** *The* FIGURES *in Brackets refer to the* NOTES *subjoined to each Section.*

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
GREENWICH, Royal Observatory .....[1]	51 28 40	0 0 0	18 30	The Astronomers Royal.
London, Cupola of St. Paul's Cathedral	51 30 49	0 5 47		The Grand Trigonometrical or Ordnance Survey, one of the great works of which our country ought to feel proud. It was commenced with a view to ascertain the difference of longitude between the Observatories of Paris and Greenwich, under General Roy. The principal triangulation was gradually extended under the successive directions of Colonel William General Mudge, Gen. Colby, Colonel Hall, and Colonel Sir Henry James. It was completed and the account of it published in 1858. The bases upon which it is constructed were measured on the shore of Salisbury Plain, and upon Lough Foyle, Ireland, and the refinement attained may be judged of when it is stated, that the difference between the calculated and measured lengths of these bases was less than 2½ inches. The mean length of the sides of the great triangles is 35·4 miles, of which 11 exceed 100 miles in length; the longest is 111 miles, *i.e.* from Slieve Donard in Ireland, county Down, to Sea Fell, Cumberland.
		Long. E.		
Gravesend, Church	51 26 39	0 22 10	18 20	
Sheerness Flagstaff	51 26 47	0 44 50		
Harwich, old Lighthouse..	51 56 38	0 17 25		
Orfordness N. Lighthouse .	52 5 36	1 35 12	18 10	
Lowestoft Lighthouse	52 29 12	1 45 28		
Cromer Lighthouse	52 55 27	1 19 5		
Spurn High Lighthouse ..	53 34 41	0 7 11		
Flamborough Lighthouse..	54 6 58	0 4 51	19 20	
Hartlepool Heugh Light ..	54 41 47	1 10 27		
Sunderland North Pier Lighthouse.....	54 55 0	1 20 0	20 10	
Souter Point Lighthouse ..	54 58 10	1 21 30		
Tynemouth Lighthouse ..	55 1 5	1 24 52		
Farn Island, S.W. Lightho.	55 36 55	1 39 0		
Berwick Lighthouse.....	55 45 53	1 58 57		
North Foreland, Lightho..	51 22 30	1 26 48	19 20	
South Foreland, High Lighthouse.....	51 8 23	1 22 22		
Dover Castle, the Keep ..	51 7 46	1 19 23		
Folkestone Church	51 4 45	1 11 6		
New Romney Church	50 59 7	0 56 22		
Lydd Church	50 57 5	0 54 29		
Dungeness Lighthouse....	50 54 46	0 58 18	18 15	
Bexhill Church	50 50 45	0 28 48		
Beachey Head Lighthouse.	50 44 15	0 12 58	18 20	
		Long. W.		
Brighton Church	50 49 32	0 7 40		
Shoreham Church.....	50 50 0	0 16 19		
Selsey Church	50 45 19	0 45 55		
Chichester Spire	50 50 11	0 46 43		
Owers Lightvessel	50 39 41	0 39 52		
Portsmouth College	50 48 2	1 6 15	19 10	
Bembridge Lightvessel ..	50 41 40	1 1 40		
Southsea Castle.....	50 46 39	1 5 14		
Calshot Castle	50 49 7	1 18 6		
Southampton Pier.....	50 53 42	1 24 23		
Hurst Castle, East Light..	50 42 26	1 32 5		
Dunnose, Station in the Survey	50 37 8	1 11 50	19 10	
St. Catherine's Lighthouse, Isle of Wight.....	50 31 30	1 17 47		

[1] Greenwich.—From 720 observations of the Pole Star, made during 18 months of 1825 and 1826, the latitude of the Royal Observatory was deduced as 51° 28′ 38″. By a later correction it is placed 51° 28′ 40″.16; but by the Grand Trigonometrical Survey it is taken as 51° 28′ 38″.30.

ENGLAND AND WALES—Continued.

	LAT. N.	LONG. W.	VAR. 1872-3.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Needles Lighthouse	50 39 40	1 34 32	19 10	The Grand Trigonometrical or Ordnance Survey of England, &c.
Christchurch Head	50 42 38	1 44 31		
Poole Church	50 42 51	1 58 55		
Portland Upper Lightho...	50 31 18	2 27 18	19 35	
Lyme Cobb	50 43 11	2 55 29		
Hob's or Bob's Nose	50 27 50	3 26 43		Remarks.
Berry Head, Flagstaff	50 24 2	3 28 14		
Start Point, Lighthouse	50 13 18	3 38 28	20 0	As a matter of curiosity it may be mentioned that, by these elaborate computations, the equatorial radius of the earth is found to be 20,926,500 feet; and the Polar radius is 20,855,400 feet, and a mean degree of the meridian contains 364,616 feet. The ellipticity of the earth is as 293 is to 294, and the mean density is 5·316.
Bolt Head, Signal Station	50 13 15	3 48 0		
Eddystone Lighthouse	50 10 49	4 15 53		
Mewstone, near Plymouth Sound	50 18 31	4 5 33		
Plymouth New Church	50 22 22	4 7 16	20 35	
Plymouth Old Church	50 22 15	4 7 32		
St. Nicholas' or Drake's Island, Plymouth Sound	50 22 4	4 18 18		
Lighthouse, on the W. end of Breakwater	50 20 22	4 9 27		These geodetic operations have been now carried to such a degree of refinement, that the varied density of the strata in different regions has a marked effect on their results. It has been argued by Archdeacon Pratt (of Calcutta) that this is sufficient to cause a deflection of from 20″ to 30″ in the perpendicularity of the plumb-line; and this of course affects, in a corresponding degree, the determinations of the exact latitude, and with that the true figure of the earth; but it is taken now, that the depression of the poles is *about* as 294 to 295·0.
Meridian Tablet, on the Breakwater [2]	50 19 59	4 8 52		
Penlee Beacon	50 12 25	4 10 40		
Rame Head, Flagstaff	50 18 53	4 12 29	20 40	
Dodman or Deadman Point, Flagstaff	50 13 20	4 48 1		
St. Anthony's Head, Lighthouse	50 8 35	4 59 31		
Pendennis Castle, Flagstaff	50 8 49	5 2 45		
St. Kevern Steeple	50 3 7	5 5 8		
Blackhead, Flagstaff	50 0 27	5 6 35		
Lizard East Lighthouse	49 57 34	5 12 4	20 50	
St. Michael's Mount	50 7 3	5 28 37		
St. Paul's Steeple, Mount's Bay	50 5 26	5 32 43		
St. Leven's, or Guethensbras Point, Flagstaff	50 2 16	5 40 46		
Wolf Rock, Lighthouse	49 56 45	5 48 14		In the public journals of 1834, it was stated that Dr. Tiarks had ascertained, in the summer of 1822, by the comparison of sixteen excellent chronometers, carried backward and forward between Greenwich and Falmouth, that the western longitude of the latter had been given at 4·4 seconds of time, or 1 minute and 6 seconds too little, by the first Trigonometric Survey. In consequence, 29 of the best chronometers belonging to the Admiralty were subsequently committed to the care of the doctor, and a vessel was appointed wherein he was to sail, backward and forward, between Dover and Falmouth, until the longitude in time, between these stations, and between them and Portsmouth, as an intermediate station, was settled beyond any
Land's End Stone	50 4 8	5 41 31	21 25	
Longship's Lighthouse	50 4 4	5 44 43		
Scilly Islands, St. Agnes' Lighthouse	49 53 30	6 20 40	21 30	
——, St. Mary's Windmill	49 54 32	6 16 59		
——, St. Mary's Flagstaff, at the Fort	49 55 0	6 18 13		
——, St. Martin's Daymark	49 58 2	6 15 53		
Bishop Rock Lighthouse	49 52 29	6 26 39		
St. Agnes' Beacon, Cornwall	50 18 28	5 12 57	21 10	
Godrevy Island Lighthouse	50 14 32	5 23 56		
Trevose Head, Lighthouse	50 32 55	5 2 3		
Hartland Point Lighthouse	51 1 24	4 31 30		
Lundy Island, Lighthouse	51 10 0	4 40 20	21 10	
Minehead Steeple	51 12 42	4 28 4		
Braunton Sands, Lower Lighthouse	51 4 17	4 12 19		
Burnham (or Bridgewater) Lighthouse	51 14 54	2 59 52		

ENGLAND AND WALES—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Usk Lighthouse	51 32 24	2 59 33	20 25	The GRAND TRIGONOMETRICAL OR ORDNANCE SURVEY of England, &c.
Bridgewater Spire	51 7 41	2 59 39		
Avon Lights	51 30 2	2 42 15		
Bristol Cathedral	51 27 6	2 35 29	20 5	
Flatholm Light	51 22 30	3 7 28		
Swansea Castle	51 37 13	3 55 32		
Mumble's Lighthouse	51 33 59	3 58 12	20 15	doubt. The result was, as to all places on the South Coast of England, between the meridians of Greenwich and Falmouth, if 1 second be added to every 4 minutes of longitude, as given by the original Survey, the exact longitude, according to the chronometers, will be obtained. These differences have since been entirely settled by the re-examination of the triangles, now completed.
Worm's Head	51 33 56	4 18 56		
Nash Point, E. Lighthouse	51 24 13	3 33 3		
Rosilly Barrow	51 34 35	4 15 51		
Pembrea Steeple	51 41 18	4 15 28		
Tenby Spire	51 40 20	4 41 51		
Caldy Island, Lighthouse	51 37 52	4 40 59		
MILFORD Steeple	51 42 43	5 0 39	21 30	
Hulberton Church	51 42 56	5 3 11		
St. Anne's High Lighthouse	51 40 55	5 10 28		
The Islet Grassholm	51 43 55	5 28 40		
Smalls Lighthouse	51 43 14	5 40 86		
St. David's Cathedral	51 52 56	5 14 53		
Ramsay Island, highest point	51 51 43	2 20 44		
Bishop and Clerks, northernmost	51 54 10	5 23 6		
Cardigan Isle, highest point	52 7 54	4 41 26		
Cardigan Steeple	52 4 59	4 39 17		
Aberystwith, Lighthouse	52 24 48	5 4 24	21 5	
Aberystwith, Station	52 25 49	4 3 19		
Cardigan Bay Lightvessel	52 24 0	5 0 0		
Bardsey Lighthouse	52 44 58	4 47 55		
St. Tudwall Lighthouse	52 47 50	4 28 10		
Caernarvon Bay Lightvsl.	53 5 45	4 44 15		
South Stack Lighthouse	53 18 23	4 41 54		
Holyhead Lighthouse	53 18 50	4 37 76	21 20	
Skerries Light	53 25 15	4 36 25		
The West Mouse	53 25 4	4 33 11		
Amlwch Station	53 23 0	4 19 17		
Great Orme's Head, signal	53 20 6	3 51 7	21 5	
Abergelé or Abergali Steeple	53 17 8	3 34 57		
Air Point Lighthouse	53 21 24	3 19 15		
Leasowe Lighthouse	53 24 46	3 7 28		
Bidstone Lighthouse	53 24 2	3 4 23		
Black Rock Lighthouse	53 26 38	3 2 2		
LIVERPOOL, St. Paul's Church	53 24 39	2 59 30	20 45	
North-West Lightship	53 30 20	3 31 30		
Formby Lighthouse	53 32 19	3 3 55		
Formby N.W. Mark	53 32 32	3 5 28		
Rossal Point Landmark	53 55 15	3 2 56		
Fleetwood New Lighthouse	53 55 35	3 0 22		
Wyre Lighthouse	53 57 12	3 1 46		
Lancaster Steeple	54 3 4	2 48 14		
Walney I. Light	54 2 54	3 10 33		
St. Bees Head, Lighthouse	54 30 48	3 38 8	21 15	
Whitehaven, Pier-head Lighthouse	54 33 10	3 35 50		
Lee Scar Lighthouse	54 51 46	3 24 43		

ENGLAND AND WALES—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Skinburness Lighthouse ..	54 52 46	3 22 46		The GRAND TRIGONOMETRICAL or ORDNANCE SURVEY of England.
Workington Chapel	54 38 28	3 34 11		
Southerness, Lighthouse ..	54 52 22	3 35 37		
Criffell, Station in the Survey, 1,831 feet above the sea	54 56 44	3 36 55		
ISLE OF MAN.				
Point of Ayre Light....	54 24 56	4 22 1	21 40	
North Berule, Station, 1,804 feet high	54 17 27	4 23 32		
Snea Fell, Stat. 2,400 ft.	54 15 50	4 27 35		
Chicken Rock Lightho. .	54 2 0	4 50 45		
Peel, Lighthouse	54 12 45	4 42 33		

NOTES.

1. The Maritime Surveys of our coasts are now so complete (with some partial exceptions), that little can be desired for the use of the navigator. These works, based chiefly upon the Ordnance Survey, would occupy too much space here to enumerate; but it would seem to be somewhat unjust if no allusion was made to the predecessors of our present government surveyors, who, with very limited means and great personal labour, produced such excellent charts, that even in the present day they would be most trustworthy guides. The names of the two Murdoch Mackenzies, Græme Spence, and Joseph Huddart, deserve especial mention.

VARIATION OF THE COMPASS.

In the latter part of this volume, some observations on the general subject will be found, among which, as to the secular change, which has now increased to a considerable amount since many of the surveys were made, and which therefore requires attention, the more especially since the introduction of an improved class of instruments, and the care demanded in the navigation of iron ships. We have given the present variation, reserving such remarks upon former results for the section specially devoted to the subject.

The variation is now *decreasing* on the Coast of England at the rate of about 9′ or 10 per annum.

2.—ISLANDS AND COASTS OF SCOTLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
EDINBURGH; the Observatory .....[1]	55 57 23	3 10 46	21 30	The GRAND TRIGONOMETRICAL or ORDNANCE SURVEY of Great Britain, at present under the direction of Colonel Sir Henry James.
Inchkeith Lighthouse	56 2 1	3 8 5		
Isle of May Lighthouse ..	56 11 8	2 33 21		
East Lomond, 1,471 ft.....	56 14 31	3 13 10		
Fifeness	56 17 0	2 31 40		
Bell Rock Lighthouse	56 26 4	2 23 7		
Dundee Law	56 28 41	2 58 26	21 20	
Buddon-ness, High Light .	56 28 7	2 44 53		

ISLANDS AND COASTS OF SCOTLAND—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Arbroath, the Abbey	56 33 45	2 34 53		THE GRAND TRIGONOMETRICAL or ORDNANCE SURVEY, as before stated.
Red Head	56 36 55	2 29 24		
MONTROSE, Round Tower	56 42 5	2 26 6		
„ Spire	56 42 31	2 27 51		
Girdleness Lighthouse	57 8 15	2 3 2		
ABERDEEN, Marischal Coll.	57 8 57	2 5 42	21 15	
Aberdeen N. bkwtr. Ltho.	57 8 33	2 4 6		
Old Aberdeen; Northern blunt Spire	57 10 11	2 6 3		
Belhelvie or Orrock, Dovecote	57 15 52	2 3 57		
Buchanness Lighthouse ..	57 28 14	1 46 22		
Peterhead, Old Mill	57 30 44	1 47 32		
Rattray Head, Pile	57 36 52	1 50 39		
Fraserburgh Lighthouse ..	57 41 51	2 0 6		
Kinnaird Head Lighthouse	57 42 0	2 1 0		
Troup Head, Staff.....	57 41 38	2 17 38		
Macduff, Spire	57 40 5	2 30 0		
Covesea Skerries, Lightho.	57 43 15	3 20 20		
TARBETNESS, Lighthouse..	57 51 55	3 46 31	22 40	
Noss Head, Lighthouse ..	58 28 38	3 2 5		
Duncansby Head, Station..	58 40 22	3 1 7		
Dunnet Head, Lighthouse	58 40 19	3 22 29		
ORKNEY—Pentland Skerries, Upper Light..[2]	58 41 26	2 55 23	22 20	
Stromness, Church	58 57 49	3 23 11		
Hoy, Wart Hill.....	58 42 2	3 20 19		
Cantick Head, Light ..	58 47 0	3 31 50		
Start Point of Sanda, Lighthouse.....	59 16 42	2 22 30	21 30	
N. Ronaldshay, Lt.-ho...	59 23 5	2 22 10		
Stronsay, Statn. in Survey	59 5 38	2 32 34		
Fair Island, summit	59 32 54	1 37 50		
Foul Island, sum. (1,369 ft.)	59 8 28	2 5 40	21 10	
North Rona Island.....	59 7 16	5 48 47		
SHETLAND — Sumburgh Head Lighthouse	59 51 7	1 16 23	21 35	The OBSERVATIONS of Mr. Geo. Thomas, R.N., on his Survey of Shetland, &c., 1825 to 1833.
Brassa Island, summit ..	60 7 51	1 5 49		
LERWICK; the Fort Flagstaff...	60 9 22	1 8 41		
Gardie House on Brassa	60 9 24	1 7 40		
Whalsey Island, summit	60 20 1	1 0 22		
Brury Isle, Out Skerries	60 2 41	0 45 2		
Yell Isle, Reafrith Kirk	60 35 55	1 3 46		
Strandburg Ness, Fetlar	60 33 51	0 33 36		
Fetlar Isle, summit	60 37 12	0 51 56		
Haaf Gruna, summit....	60 39 44	0 50 24		
Balta Island, summit....	60 45 3	0 47 17	21 30	
Saxavord, Stat. in Survey	60 49 39	0 50 20		
Lambness, on Unst.....	60 49 0	0 45 40		
Burraford Holmes.....	60 51 0	0 53 30		
Ramna Stacks	60 39 36	1 18 40		
Ve Skerries, off St. Magnus Bay	60 22 30	1 49 10		
Fugloe Skerry, near Papa	60 20 15	1 45 0		
Scaloway Castle	60 8 31	1 16 25		

ISLANDS AND COASTS OF SCOTLAND—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
WESTERN COASTS.	° ′ ″	° ′ ″	° ′	The ADMIRALTY SURVEY, based on the Ordnance Triangulation.
Holburn Head	58 37 30	3 31 50	22 40	
Cape Wrath Lightho. [3]	58 37 33	4 9 52		
Laxford, N.W. Point	58 24 40	5 8 20		
Ru Stoer, Lighthouse	58 15 52	5 22 12		
Butt of the Lewis	58 31 0	6 15 35	24 40	
Ru Rea, Statn. in Survey	57 50 8	5 45 53		
Stornoway Lighthouse, in Lewis	58 11 30	6 22 10		
Cleisham, in Lewis	57 57 49	6 48 38		
Glash or Scalpa, Lightho.	57 51 26	6 38 3	24 45	
Storr Hill, in Mull	57 30 25	6 10 52		
St. Kilda; Peak at N.E. end	57 49 2	8 35 30		
Ben More, S. Uist; Statn.	57 15 31	7 17 35		
Barra Head, Lighthouse ..	56 47 8	7 39 9	25 0	
Skerryvore Lighthouse ..	56 19 24	7 6 45	24 15	
Dubh Artach Lighthouse..	56 8 0	6 38 0		
Ardnamurchan Pt. Lt.-ho.	56 43 45	6 13 30		
Tobermorey Mull; Lt. on Runa Gal Rock	56 38 0	6 3 40		
Lismore Lightho., Sound of Mull	56 27 20	5 36 23	24 0	
Ben Tartevil, or Tart-a-bhaile, Islay Island	55 43 32	6 26 32		
Rhynns of Islay Lightho.	55 40 23	6 30 44		
Jura Island, N. Pap. 2659 feet	55 54 8	6 0 8		
Mull of Cantyre, Lightho.	55 18 38	5 48 8	23 0	
Sanda Island, Ship Rock Light	55 16 30	5 34 55		
Campbelltown, Devaar Lt.	55 25 45	5 32 16		
Goat Fell, Arran Island ..	55 37 52	5 11 24		
Ben Lomond, Station in Survey	56 11 24	4 37 52		
Troon Lighthouse	55 34 37	4 41 39		
Pladda Lightho., Arran Id.	55 25 30	5 7 2		
Little Cumbrae, New Lighthouse	55 43 16	4 57 57		
Toward Point, Lighthouse	55 51 44	4 58 43		
Ayr Lighthouse.....	55 28 9	4 38 11		
Turnberry Point Lighthouse	55 19 30	4 50 20		
Corsewell Point, Lightho.	55 0 25	5 9 30		
Mull of Galloway, Lightho.	54 38 5	4 51 22	22 15	
Southerness Lighthouse ..	55 52 22	3 35 37		

NOTES.

1. EDINBURGH.—The geographic position of the Astronomical Observatory on the Calton Hill, was given by the Ordnance Survey, in 1816, as longitude 3° 10′ 54″ W. But this result appears to have been affected by a singular cause, which demonstrates the refinement to which these operations have been carried. It has since been found that the attraction of the mass of Arthur's Seat (a hill to the southward of it) has drawn the plumb-line (or zenith sector) towards it, and thus produced an error of several seconds in the calculation. This error was established in 1839, by Professor Henderson, who made

the longitude 3° 10′ 45″. Some interesting experiments were made on this curious point, during the late Ordnance Survey, by which, not only the effect of mountainous masses on surveying operations was ascertained, but also the density of the earth was established.

Since the completion of the triangulation of the Ordnance Survey, a new principle for ascertaining the difference of longitude has come into operation. The extension of the electric telegraph has placed Greenwich Observatory in direct connection with most other important Observatories; and in April, 1857, a series of instantaneous signals was transmitted between it and Edinburgh, under the direction, at the latter place, of Professor Piazzi Smyth, the worthy son of the excellent Admiral Smyth, well known to all sailors. These experiments definitely settled its longitude at $12^m\ 43\ 048^s$ in time, or 3° 10′ 45.72″ in arc, concerning Mr. Henderson's previous result.

2. Orkneys, &c.—The Orkney Islands were originally surveyed by the elder Mackenzie. Murdoch Mackenzie, F.R.S., was the first surveyor of our coasts, who conducted his operations on right principles. His first work, *Orcadia, or the Orkney Islands, with part of Lewis*, was done at his own expense. Its accuracy is great, and its utility is still unequalled. It was published in 1750. He was afterwards employed by the king in surveying the coasts of Ireland, &c. Later in life his works were attacked, most unjustly, by Dr. Anderson, which called forth suitable replies and justification from John Clark, of Eldin, in 1785. This work may be said to have commenced the Admiralty Surveys.

3. West of Scotland, and the Hebrides.—Up to quite a recent date the charts of the whole of this portion of our shores remained nearly in the same state that they were left by Murdoch Mackenzie. Notwithstanding their imperfections, however, statistics have shown that no great detriment to navigation arose from their "disgraceful" condition, an epithet which took 25 years of organized surveying parties, and £250,000 to remove.

We may here add that they were examined, and partially surveyed, by Captain Joseph Huddart, whose charts were long of good service. Captain Huddart also surveyed a great portion of the St. George's Channel at the expense of the predecessors of the publisher of this work.

3.—COASTS OF IRELAND, ETC.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
The Northern Coast.	° ′ ″	° ′ ″	° ′	The Surveys of Capt. Wm. Mudge, R.N., F.R.A.S., made in co-operation with the Grand Trigonometrical Survey of Ireland, 1828-52.
Tory Island, Lighthouse ..	55 16 27	8 15 0	24 20	
Fannet Point, Lighthouse	55 16 34	7 37 52		
Innistrahul, Lighthouse ..	55 25 56	7 13 37		
Inishowen Head, Lightho.	55 13 38	6 55 38		
Magilligan Tower, L. Foyle [1]	55 11 32	6 57 58		
Port Rush	55 12 30	6 50 15	23 15	
Bengore Head	55 15 0	6 28 35		
Rathlin Isle, Church.....	55 17 35	6 12 2		
„ Lighthouse ..	55 18 10	6 10 40		
Knocklaid Mountain (1,690 feet).....	55 9 43	6 14 57		
Fair Head	55 13 30	6 9 30	23 5	
The Eastern Coast.				
Tor Point	55 11 50	6 4 10	23 5	
Gorron Point.....	55 3 0	5 58 30		
The Maidens, South Rock Light	54 55 54	5 43 5		
Hunter Rock (9 feet)	54 52 45	5 45 30		

COASTS OF IRELAND, ETC.—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Black Head	54 46 0	5 42 0		The GRAND TRIGONOMETRICAL SURVEY of Ireland, and the Surveys of the late Captain Mudge and other Officers, 1828-52.
Carrickfergus Castle	54 42 35	5 49 15		
BELFAST, Mouth of the Lagan	54 36 0	5 56 0	22 35	
„ Divis Mt. (1,800 ft.)	54 36 40	6 1 0		
Bangor Castle	54 39 20	5 40 40		
Copeland Lighthouse	54 41 45	5 31 80		
Donaghadee, Pier Head	54 38 38	5 32 25		
Ballyhalbert, Fort	54 29 30	5 28 10		
South Rock	54 23 56	5 25 4		
St. John's Point, Lighthouse	54 13 34	5 39 30		
Slieve Donard (2,797 ft.)	54 10 48	5 55 9		
Carlingford Lighthouse	54 1 11	6 4 4	22 45	
„ Hill (1,580 ft.)	54 2 39	6 13 9		
Clogher Head	53 47 40	6 14 0		
Drogheda, centre	53 42 50	6 22 0		
Balbriggan, Light	53 36 46	6 10 53		
St. Patrick's Island	53 34 45	6 5 20		
Rockabill Lighthouse	53 35 45	6 0 30	22 20	
Lambay Island, summit	53 29 20	6 2 0		
Howth Hill, peak (565 ft.)	53 22 23	6 4 3		
Howth Bailey, Lighthouse	53 21 5	6 3 5		
Poolbeg Lighthouse	53 20 31	6 9 1		
DUBLIN, Nelson's Pil. [2]	53 21 0	6 16 45	22 30	
Kingstown, Lighthouse	53 18 5	6 9 0		
Wicklow Head Upper Lt.	52 57 54	6 0 5		
Tara Hill	52 41 56	6 12 58		
Fourth Mountain	52 18 57	6 33 39		
Roslare Sand Hill	52 19 45	6 22 21		
Tuskar Lighthouse	52 12 9	6 12 22	22 5	
THE SOUTHERN COAST.				
Saltees Lightvessel	52 2 18	6 38 15		
Coningmore Rock	52 4 45	6 37 49		
Hook Lighthouse, near Waterford	52 7 24	6 55 43	22 25	
Helwick Head	52 3 6	7 32 40		
Mount Knockmeldown	52 13 33	7 55 0		
Roche Point, Lighthouse	51 47 33	8 15 14		
Daunt's Rock Lightvessel	51 43 0	8 17 0		
Robert Head	51 43 55	8 20 0	23 5	
Kinsale, Southern Light	51 36 11	8 31 58		
Galley Head Lighthouse	51 31 50	8 57 10		
Stags of Castlehaven	51 28 15	9 13 46		
Cape Clear, Old Lightho.	51 26 2	9 29 30	23 40	
Fastnet Rock, Lighthouse	51 23 18	9 36 25		
Crookhaven, Lighthouse	51 28 35	9 42 31		
Mizen Head	51 27 15	9 50 0		
Mount Gabriel	51 33 30	9 32 0		
Sheep Head	51 32 55	9 51 40		
Hungry Hill, Station in Survey	51 41 13	9 47 27		
Roancarrig Island Ltho. in Bantry Bay	51 39 10	9 44 49		
Signal Tower, Bear Island	51 37 43	9 53 40	24 5	

COASTS OF IRELAND, ETC.—Continued.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
The Western Coast.	° ′ ″	° ′ ″	° ′	
Dursey Island, South Pt...	51 35 5	10 14 10		The Grand Trigonometrical Survey, &c.
Bull Rock	51 35 50	10 18 30		
Skelligs, Lighthouse.....	51 46 6	10 32 20		
Valentia Isle, Fort Cromwell.....	51 56 50	10 19 15	24 35	
Valentia Isle, Feaghmaan Station at West end [3]	51 55 22	10 20 41		
Doulus Head	51 57 6	10 19 0		
Dunmore Head, Dingle Bay	52 6 3	10 29 0		
Tearaght Island Lighthouse	52 4 30	10 40 0		
Foze Rock	52 1 0	10 39 40		
Inishtuiskero Island	52 7 20	10 34 30		
Mount Brandon, Station ..	52 14 6	10 15 10		
Kilcradan Head, Lightho.	52 34 4	9 42 34		
Scattery Id., Round Tower	52 36 42	9 31 15		
Loop Head, Lighthouse ..	52 13 38	9 55 56	24 30	
Mutton Island, Lighthouse	53 15 14	9 3 10		
Arran Island, Lighthouse..	53 7 38	9 42 6		
Slyne Head, N. Lighthouse	53 23 59	10 14 1		
Inishgort Lighthouse	53 49 35	9 40 12		
Clare Island Lighthouse ..	53 49 38	9 58 58		
Achil Head	53 58 20	10 16 0	25 20	
Slieve More, Achil Island..	53 0 35	10 3 26		
Eagle Island, Lighthouse..	54 16 59	10 5 32		
Tawnaghmore, Station....	54 17 39	9 35 47		
Telling or Teelin Head....	54 40 30	8 46 10		
Rathlin O'Birne Lightho...	54 39 47	8 49 52	24 25	
St. John's Point, Lightho.	54 34 8	8 27 33		
Ballyshannon Church	54 30 11	8 11 47		
Slieve League (*summit* 1,977 feet)	54 39 5	8 42 38		
Bloody Farland (*summit* 1,060 feet)	55 8 14	8 15 41	24 15	
Muckish Hill, eastern part	66 6 21	7 59 49		

NOTES.

1. The positions of places on the Irish coasts depend upon the observations made in the Trigonometrical or Ordnance Survey. The principal triangles, commencing with the measurement of the base on the East side of Lough Foyle, in 1826-8, have been extended over the whole area, between that period and 1832, and give results which may be practically taken as absolutely correct.

Since that period, the minute surveys of the land, on a very large scale, have also been completed; and upon this basis our Admiralty surveyors have constructed our present charts, by adding the soundings and maritime features outside the low water-line. This series has only recently been completed for the use of the sailor, as shown on our charts, The names of Mudge, Bedford, Wolfe, Beechey, Frazer, Church, and other officers, should be mentioned in connection with those operations.

2. Dublin.—The Astronomical Observatory, 3 miles N.W. of Dublin, in lat. 52° 23′ 13″, and longitude 6′ 20′ 30″, is a point verified by triangulation as well as by observation.

3. Valentia.—One of the most important geodetical operations in connection with the Ordnance Survey, was the chronometric determination of the difference of longitude

between Valentia and Greenwich, in December, 1845. This arc, one of the largest that could be measured in the British Isles, has been of very great importance, as well in verifying the accuracy of the Trigonometrical Survey, as in determining the true figure of the earth. It was carried on by Professor Airy, the Astronomer Royal, assisted by Mr. Sheepshanks, Mr. Hartnup, Mr. Hind, and several other observers, by means of thirty pocket chronometers. The stations were Greenwich, Liverpool Observatory, a temporary Observatory at Kingstown, and Feaghmaan at Valentia. The final determination of the longitudes, chronometrically, were—Liverpool, $12^m\ 0.05^s$; Kingstown, $24^m\ 31.20^s$; and Valentia, $41^m\ 23.23^s$. By the Ordnance Survey, these longitudes were made—Liverpool, $12^m\ 0.35^s$; Kingstown, $24^m\ 31.48^s$; and Valentia, $41^m\ 23.07^s$.

4.—NORWAY AND SWEDEN.

	LAT. N.	LONG. E.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Moudiuga Island, Berezov Bar, Lighthouse	64 54 50	40 17 0	6 0	Russian Surveys.
Swiatoi Nos, Lighthouse	68 8 50	39 48 50		
LOFOTEN ISLANDS, Svolvaer Light	68 13 15	14 37 0	WEST. 14 0	The TRIGONOMETRICAL SURVEY, may by order of the Norwegian Government, by Capt. Vibe, &c., as explained in the Notes.
Vaago or N. Hellig Vaer Lt.	67 26 0	14 1 40		
Nyholmen, Lighthouse	67 17 0	14 24 0		
Træ Island, Söe Id., Lt.-ho.	66 25 50	11 59 50		
Andersbak Id., Lighthouse	66 15 45	12 19 0		
Mangvardkua, conical ben.	66 13 30	12 41 20		
Donnæs öe, Church at N. end	66 12 5	12 36 30	14 0	
„ Björn Market-place	66 5 0	12 35 30		
„ Donnæs Fjeld	66 2 0	12 24 0		
Alsten öe, Syv Sostre Mts. South one	66 55 0	12 32 0	14 0	
Skjærvær I., Klep Harbour	65 46 45	11 35 40		
Sola Island, summit	65 40 20	11 45 0		
Vegen I., Gulsvaagfjeld Mt.	65 39 15	11 51 0		
„ Vegtinden Mt.	65 37 45	11 54 0		
Sjelva Beacon, off Minland	65 43 25	12 19 50		
Höiholmtinderne Mt. S. pk.	65 36 0	12 26 0		
Andalshatten Mountain	65 33 32	12 26 0		
Kvalöe, summit	65 13 30	12 1 0	14 0	
Helgeland Oflissen beacon, off Kvalöe	65 13 10	11 54 30		
Heilhornet, remarkable Mt.	65 4 32	12 9 12		
Leköe, summit	65 4 43	11 37 30		
Vigten Islands; outer Id., N.E. point	64 58 25	11 11 0	14 30	
„ Sulafjeld Mount	64 54 0	10 49 0		
„ Indre or Inner Id. Rorvig, on E. side	64 51 30	11 15 0		
Folden Fjord, Grinna beacon on North side	64 45 10	10 59 20		
Præstoe Light, near Næröe	64 47 25	11 7 45		
Gjöen, Brakstad	64 40 20	11 13 0		
Otter öen, Findanger Fjeld	64 36 25	11 7 0		
Halmöe, Villa Lighthouse	64 32 50	10 41 55	14 20	
Oxbaasheia, Village at N. end	64 32 30	10 25 50		
Buholmene, cone beacon	64 25 0	10 26 20		
Vigs Sjelen, summit	64 15 30	10 24 0		
Osen, Church	64 17 45	10 31 30		
Alminding öe, Hvalhovden or S. point	64 10 0	10 1 30		

NORWAY AND SWEDEN—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Halten Island, Light	64 10 0	9 27 30	15 50	The TRIGONOMETRICAL SURVEY, made by order of the Norwegian Government, by Capt. Vibe, &c., as explained in the notes.
Leikua Beacon, off Lysö ..	63 55 40	9 57 30		
Snuls Fjord, Sulen Tower	63 50 45	8 33 10		
Fröien Island, Titterodden, or West point	63 40 5	8 19 10		
Ulv ö, centre	63 40 0	9 9 0		
Great Kopperen Hill, on Mainland	63 48 4	9 43 0		
Hitteren Id., Börö, E. end	63 34 20	9 18 20		
„ Omdasfjeld, on N. side	63 33 35	8 43 0	17 0	
Trondhjem Channel, Terningen Lighthouse	63 30 35	9 7 50	15 30	
Trondhjem Channel, Agdenæs Lighthouse.....	63 38 0	9 49 30		
TRONDHJEM, Munkholmen Light	63 27 30	10 27 30	14 30	
„ Cathedral [2]	63 25 49	10 27 40		
Smoelen Island, Maaberg Tuva, on North side	63 26 38	8 3 30		
Eddö; Trondhjem S. channel, Light on Ringholm	63 19 20	8 14 50		
Grib Island, centre	63 14 9	7 35 40		
Olan Kalv	63 7 40	7 11 20		
Stavenæs Lighthouse	63 7 40	7 40 0		
Aver ö, Quaernaes	63 1 40	7 43 40		
„ Mæknokken Mt...	62 59 0	7 32 30		
Christiansand, S.W. end of town	63 7 10	7 42 50	16 30	
Frey öen, Frey Kollen Mt.	63 2 30	7 44 0		
Qvitholm, Lighthouse	63 2 15	7 14 0		
Stevshest, summit	62 59 0	7 12 0		
Böesund, Boeværet Church	62 55 0	6 54 15		
Sandö, Church	62 49 31	6 36 10		
Romsdals Oerne, Harr ö Church	62 47 0	6 28 10	17 25	
„ Harams ö, Light at N.W. end	62 41 2	6 10 15		
„ Lepsö, Lightvessel on reef.....	62 35 15	6 15 30		
Walderö, Light on S.E. pt.	62 29 50	6 8 5		
God-ö, Lt. on Hogstein Pt.	62 27 45	6 2 10		
„ Lt. on Alnæs Tang	62 29 20	5 58 20		
Hessö, Sugar Loaf	62 27 30	6 6 20		
Rondö, Lighthouse	62 25 0	5 36 0	17 45	
Svinö, centre	62 19 45	5 16 30		
Stadtland, Quitenæs at N. end	62 12 35	5 14 30		
„ Fureness	62 6 0	5 7 40		
Bremanger Land, Olderveggen Point	61 51 30	4 49 15		
Froe Soen, Smor Haven Lt.	61 45 45	4 55 45	18 0	
Battalen, summit	61 39 0	4 47 30		
Kind ö, Lighthouse	61 33 40	4 45 25		
Bue Land, Yststeen	61 17 30	4 36 10		
Udvær, Anchorage	61 2 30	4 28 40		
Feve Oosen, Lt. on Hellisö	60 45 0	4 40 5		

NORWAY AND SWEDEN—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Bergen, North Channel, Holmengraa	60 50 30	4 37 40		The TRIGONOMETRICAL SURVEY, &c., as before stated.
Bergen Holzenö, Light on Skællanger	60 36 30	4 55 30		
Bergen, Cathedral	60 23 30	5 17 50	17 40	
Bergen, Light on Nordnæs	60 23 50	5 15 50		
Lecrö, Light on W. side	60 14 0	5 9 0		
Kors Fjord, Marsteen, Lt-house	60 7 45	5 1 0		
Piir Holm, Light	60 6 0	5 8 0		
Selbö, Ox'hammer, Light on East end	59 59 15	5 12 30		
Selbö Fiord, Furren beacon	59 58 0	5 2 0	17 30	
„ Slotterö, Light	59 54 30	5 3 10		
Stoksund, Light on Folgeröe	59 48 0	5 18 20		
Bommel Fiord, Ryvarden Light	59 31 40	5 13 40		
Roevaer Island, Light on Gitterö	59 26 5	5 7 40		
Särhougsund, N. entrance Light	59 25 25	5 14 45		
Udsire Island, W. Light-house	59 18 20	4 53 0	17 40	
Karmö, Skudesnæs Light-house	59 8 20	5 18 0		
Bukkesund, Light on Bukken	59 13 25	5 27 35		
Hviddings ö, Lighthouse	59 3 30	5 24 20		
Stavanger, Church	58 58 12	5 45 15	17 5	
Tungenæs, Lighthouse	59 2 0	5 35 0		
Fladholmen Lighthouse	58 55 20	5 33 20		
Little Feisteen Lighthouse	58 49 30	5 30 55		
Jocderens Point beacon	58 45 5	5 29 30		
Obrestadbrækka, Light	58 39 30	5 33 30		
Warhoug, Church	58 36 38	5 37 15		
Ekersund, Vibberodden Lt.-house [3]	58 25 5	5 59 35	16 45	
Varnæs Lighthouse	58 10 35	6 37 45		
Lister Lighthouse on Gunnarshoug	58 6 30	6 34 10		
Lindesnæs or Naze, Light-house	57 59 0	7 3 0	16 0	
Ryvingen beacon	57 58 10	7 29 20		
Helleö, beacons	58 3 5	7 51 5		
Christiansand, Church	58 9 0	7 59 50	15 0	
Odderö, Lighthouse	58 8 10	8 0 30		
Oxö, Lighthouse	58 4 25	8 3 35		
Ulvö, Outer beacon	58 6 50	8 13 5		
Justö, Beacon on Reiers-kjær	58 11 50	8 23 45		
Homborgö, Beacon at East end	58 15 20	8 31 30		
Hesnæs, Beacon	58 20 20	8 41 0		
Torungen, Inner Lightho.	58 24 50	8 48 0		
Sandvigodden Lighthouse	58 26 20	8 47 25		

NORWAY AND SWEDEN—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″		
Torungen, Hiser ö, Outer Lighthouse	58 24 5	8 47 45		The TRIGONOMETRICAL SURVEY, &c., as before stated.
Tromö, Church	58 27 0	8 52 15		
Tromo Sund, Bonden beacon at entrance	58 31 30	8 59 40		
Sandö, cone beacon at N.E. point	58 36 10	9 5 5	14 50	
Osterrisör, Stangholmen Lighthouse	58 42 40	9 15 0		
Sondelov, Church	58 46 0	9 5 28		
Kragerö, S. end of town	58 52 0	9 23 45		The TRIGONOMETRICAL SURVEY, by Lieutenant Schie, and Messrs. Diriks and Wille.
Jomfruland Lighthouse	58 52 10	9 36 15	14 10	
Langötangen, Lighthouse	58 59 45	9 45 50		
Frederiksværn, Staværnsö Lighthouse	58 59 30	10 3 30		
Svenöer Lighthouse	58 58 5	10 9 10		
Little Færder Lighthouse	59 2 0	10 32 5		
Fulehuk Lighthouse	59 10 45	10 36 15		
Christiania, New Observatory	59 54 42	10 43 28	14 0	
Torbiornskiær, Light	58 59 15	10 47 20		
North Koster Lighthouse	58 54 10	11 0 30		
Segelskiær	58 46 35	11 59 50		
Stromstad, Church	58 56 18	11 11 0		
Waderöbod, Light	58 32 55	11 2 15		
Hällö Lighthouse	52 20 11	11 13 40		
Maseskar Lighthouse	58 5 50	11 20 20		
Marstrand, Carlsten Light	57 53 40	11 35 0		
Winga Lighthouse	57 38 0	11 36 20	13 0	
Gotheborg Town	57 41 55	11 56 40		

NOTES.

1. COAST OF NORWAY.—The Trigonometrical Survey of the Western Coasts of Norway to the northward of Trondhjem, was commenced by Lieut. Vibe, assisted by Lieuts. Paludan and Hagerup, in June, 1828, by order of the Norwegian Government. It was continued by those officers, under the direction of Captain Vibe, to the frontiers of Russian Lapland, till 1849. Their elaborate charts, published at intervals, between 1835 and 1849, show the extraordinary features of this coast—a complete labyrinth of islets and rocks—which all written descriptions must utterly fail in giving any notion of. We have given the positions of the more prominent land-marks, but there are few points which can be made available for the mariner's use, except the information afforded by their valuable charts.

2. TRONDHJEM, &c.—The ancient cathedral of Trondhjem or Drontheim, once one of the finest in Europe, was the northern limit of the survey carried on by the Danish Government, prior to the transfer of the courts to Sweden.

The coasts to the South were trigonometrically and astronometrically surveyed by Commissioner N. A. Vibe, before mentioned, assisted by Lieut. D'Aubert and Capt. C. F. Grove, as far as Stavanger and Egefield. The charts issued under Admiral Klint (a well-known name), leave little to be desired, and the nature of the country, the geological formation being of primary gneiss, granite, and other very hard rocks, will prove that but little change can arise from the wear of the sea.

3. EKERSUND OR EGGERSUND, &c.—The charts of the South Coast of Norway, between

Eglefield and Jedderen and Christiansand, were published in 1800. The triangulation was carried on by the same officers as before mentioned, Captains Grove and Vibe, and Lieut. D'Aubert.

This section of the coast is dependant on the positions of Stavanger and Christiansand Churches. Lindersnæs, or the Naze of Norway, as it is generally called, was made by the triangulation to be in latitude 57° 58′ 0″ N. By the astronomical observations of Messrs. Rich and Vibe, in 1781, 57° 58′ 48″ N.

Between Ekersund and Christiansand, the triangulation was re-examined in 1855-6, by Lieutenant Schie, assisted by Herr C. Diriks and Lieutenant H. Wille; between Arendal and Jomfruland, these operations were carried on by the same officers in 1853-5. The portion of coast between Arendal and Christiansansand was examined in 1854-5, by Herr Diriks and Lieut. Wille, under Major Vibe.

The VARIATION of the COMPASS is now *decreasing* at the rate of 6′ to 6′ 30″ per annum.

5.—DENMARK, GERMANY, HOLLAND, AND BELGIUM.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
WEST COAST OF DENMARK.	° ′ ″	° ′ ″	° ′	The Chart published by the DANISH GOVERNMENT, 1841.
Skagen or Skaw Point, New Lighthouse	57 44 9	10 37 56	13 40	
Hirtshals, Lighthouse	57 34 45	9 56 30		
Venneberg, Church	57 27 28	9 49 30		
Lökken, Lifeboat-house	57 22 0	9 42 0		
Börglum Kloster, mansion	57 22 5	9 47 10		
Bolbierg Bluff (360 ft.)	57 9 7	8 59 30		
Hantsholm, Lighthouse	57 6 50	8 36 40	14 50	
Klitmölle	57 2 15	8 30 0		
Blokkenbierg	56 49 45	8 14 56		
Ron Channel, entrance	56 42 40	8 13 0		
Bovbierg Head Light	56 30 40	8 7 10		
Husby, Church	56 16 30	8 10 45	15 10	
Holmsland, New Sogns Church	56 16 55	8 10 55		
Ringkiöbing, Church, 5 miles inland	56 5 30	8 15 0		
Nymind Gab, entrance	55 47 0	8 11 25		
Blaavands Huk, extreme	55 33 30	8 4 15		
Horn Reef, Outer patch, 16 feet	55 30 0	7 41 5		
Hjerting, landing-place	55 31 35	8 21 10	15 10	
Fanö, Nordby North beacon	55 27 30	8 23 30		
Manö, Church	55 15 25	8 31 40		
Romö, St. Clemens Church	55 6 55	8 32 30		
Sylt Island, Lighthouse on List, or North end	55 3 10	8 23 40	15 40	
——— Rode Klif, or Red Cliff Light	54 57 42	8 20 0		
——— Hornum Odde, Station in Survey	54 45 58	8 16 32		
Amrum, St. Clemen's Church at Nebel	54 39 22	8 21 35		
Amrum, Lighthouse at S. end	54 38 28	8 22 32		
Fartrapdyb, entrance	54 36 0	8 13 30		
Smalldypt, outer buoy	54 30 0	8 17 0		

DENMARK, GERMANY, HOLLAND, ETC.—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Föhr Island, Wyk Church	54 41 25	8 34 12		
Dagebüll Harbour Light	54 43 40	8 41 20		
Husum, Church	54 28 45	9 3 10	14 40	
Ording, Church	54 20 15	8 36 25		
Eiderstedt, Hitz Bank beacon	54 17 10	8 39 0		
Tonning, South Church	54 18 55	8 56 30		
Büsum, Harbour	54 7 40	8 51 50		
Helgöland, Lighthouse	54 10 49	7 53 0	14 45	
Bösch Sand beacon [1]	54 5 30	8 37 50		The Survey made by the PRUSSIAN ADMIRALTY, 1858, 1859-1868.
Elbe River, Outer Light-vessel No. 1	54 0 10	8 18 30	14 15	
—— Scharhörn Beacon	53 57 16	8 24 35		
—— Lightvessel, No. 3	53 58 30	8 31 50		
Neuwerk High Lighthouse	53 55 3	8 29 50		
Kügel or Ball Beacon	53 53 20	8 41 18		
Cuxhaven Lighthouse	53 52 28	8 42 20		
Gluckstadt, Pier Light	53 47 25	9 25 50		
ALTONA, Observatory	53 32 45	9 56 39	13 40	
Hamburg, Observatory	53 31 59	9 58 31		
Weser River, Outer Light-ship	53 54 0	7 49 0		
——— Ever Sand Beacons	53 44 15	8 21 30		
——Bremen Beacon Light-house	53 42 50	8 14 40		
Longwarden, Church	53 36 20	8 18 32		
Bremerhaven, Church	53 32 48	8 34 15	14 40	
Bremen, Observatory	53 4 36	8 42 48		
Jade River, Minsener Olde Oog Beacon	53 46 45	8 0 35		
Hooksiel, Windmill	53 38 0	8 1 22		
Wilhelmshafen, Navy Harbour entrance	53 31 0	8 9 20	15 0	
———Waterworks Tower	53 31 3	8 7 43		
Wangeroog Lighthouse	53 47 28	7 53 59		
———— Church	53 47 32	7 51 5		
Spikeroog, centre	53 45 30	7 42 0		
Langeroog, beacon on Osterende	53 45 25	7 35 55		
——— Osterende village	53 45 0	7 29 0		
Baltrum, village at W. end	53 44 5	7 22 50		
Norderney Beacon	53 43 20	7 9 50	15 10	
——, Conversation House	53 42 25	7 8 35		
Juist, Eastern Village	53 40 40	7 0 0		
COAST OF HOLLAND. [2]				
Borkum, Light-tower	53 35 10	6 40 16	15 30	The Great TRIANGULATION by Baron Krayenhoff, and the Surveys of Admiral Ryk, Captains Keuchenius, and Van Rhyn.
Rottum, House	53 32 20	6 31 46		
Delfzyl, Church	53 19 58	6 55 38		
Emden, Church	53 22 2	7 12 15		
Schiermonnik-oog, High Lighthouse	53 29 19	6 9 42		
Ameland, Hollum Church Tower	53 26 12	5 38 31		
Terschelling, Brandaris Lighthouse	53 21 40	5 12 54		

DENMARK, GERMANY, HOLLAND, ETC.—Continued.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Ha lingen, W. Ch. Tower .	53 10 29	5 24 45		The Great Triangulation by Baron Krayenhoff, and the Surveys of Admiral Ryk, Capts. Keuchenius and Van Rhyn.
Vlieland, Lighthouse near East end	53 17 48	5 3 31	16 15	
Vlieland, Posthuis near W. end	53 14 44	5 59 3		
Franeker, Steeple	53 11 14	5 32 42		
Makkum, Church Tower ..	53 3 37	5 23 59		
Bolsward, Church Tower..	53 3 55	5 3 35		
Hindeloopen, Tower	52 56 37	5 23 57		
Stavoren, Church Tower ..	52 52 57	5 21 39		
Urk Island, Church Tower	52 39 46	5 35 38		
Vollenhoven, Station.....	52 40 53	5 57 4		
Muiden Church	52 19 54	5 4 11		
Amsterdam, West Tower of Cathedral ..... [3]	52 22 32	4 5 2	16 10	
Monnikendam	52 27 29	5 2 3		
Enkhuisen, Church Tower .	52 42 15	5 17 35		
Wieringen Oosterland Tower	52 55 55	5 0 40		
Eyerland, beacon at N.E. point	53 9 50	4 50 10		
Texel, Oostereind Tower ..	53 5 5	4 53 40		
„ Hoorn, Church Tower	52 38 30	5 3 32		
Willemsoord, Time-ball on Palace .....[5]	52 57 50	4 46 36	16 25	
Kykduin Lighthouse	52 57 5	4 43 20		
Calandsoog, Steeple	52 50 10	4 41 35		
Egmond aan-Zee, Lightho.	52 37 10	4 37 20		
Noord Zee Haven, entrance	52 27 40	4 33 40		
Zandvoort, Lighthouse....	52 22 28	4 31 38		
Nordwyk, Lighthouse	52 14 35	4 25 43		
Katwyk, Lighthouse	52 12 2	4 23 28		
Leiden, Observatory [4]..	52 9 28	4 29 9	16 15	
Scheveningen Lighthouse .	52 6 20	4 16 10		
Hook of Holland Canal, N. mole-head Light	51 59 10	4 5 5		
Voorne Island, Brielle Lighthouse	51 54 11	4 10 40		
„ Hellevoetsluis, Time-ball on the Hospital	51 49 25	4 7 44	16 30	
Goedereede, Church Tower Light	51 49 8	3 58 32		
„ Stone Beacon Light, on North side....	51 48 54	3 55 22		
Schouwen Island, Brouwershaven Mill	51 43 32	3 54 32		
„ Renesse, East Light	51 44 32	3 47 52		
„ Lighthouse at West end.....	51 42 33	3 34 30		
„ Zierikzee, Gt. Tower	51 39 2	3 54 52		
Walcheren Island, Veere Great Tower	51 32 52	3 40 2		
„ West Kapelle, Light on Church Tower .	51 31 46	3 26 49		
„ Middelburg Tower	51 30 0	3 35 31		

DENMARK, GERMANY, HOLLAND, ETC.—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Walcheren Island, Flushing or Vlissingen, Time-ball at the Arsenal	51 26 20	3 35 16	16 55	The GREAT TRIANGULATION by BARON KRAYENHOFF, &c.
BELGIUM.				
BRUSSELS, Royal Observatory .....[6]	50 51 11	4 17 13	16 15	
Heist, Lighthouse	51 20 25	3 14 0		
Blankenberg, Light on Fort	51 18 55	3 8 0		
Ostende, Lt.-ho. E. of har.	51 14 25	2 55 50	16 10	
Nieuport, Light at Entrance	51 8 25	2 43 50		

NOTES.

1. ELBE AND WESER RIVERS.—The details given in the table, are taken from the Surveys of these entrances, made by the Prussian Admiralty, and published in 1868. They are based on the triangulation of Professors Gauss and Schumacher, and the details of the river re-examined by Captain F. Andreas Meyer in 1866. The entrances were re-surveyed by Captain Grapou in 1867-8. The longitudes are dependent on that of the well-known Observatory at Altona.

2. HOLLAND.—The charts of the Coasts of Holland are based upon the great triangulation of that country, by the Lieut.-General C.R.T. Krayenhoff, the account of which was published in 1813. Upon the points thus established, the coasts and channels about Vlieland, Ameland, &c., were surveyed by the late Capt.-Lieut. S. J. Keuchenius, published in 1831-34; the Texel Channels by Lieut. A. Van Rhyn, 1840; the Zuider Zee, by the same in 1841; the Schelde Channels, by the late Vice-Admiral J. E. Ryk, 1841; Goeree and the Maas, by the same, in 1827; and Brouwershaven Gat, by Capt. Keuchenius, 1826. These fine surveys are deserving of all confidence. They have been re-examined in 1860-9 by Capt.-Lieut. A. R. B. Commendal.

3. AMSTERDAM.—The triangulation of the Baron Krayenhoff was dependant on the position of the western tower of the Cathedral of Amsterdam, which was considered to be in longitude 4° 53′ 16″.86 E. Its true longitude, by electric signal, appears to be as shown 4° 53′ 2″.55 E. By a Government notice, dated August 1st, 1826, Greenwich is named as the first meridian for Netherlands hydrography.

4. LEIDEN.—The National Observatory of Leiden was established in 1854, under Professor Kaiser. Its longitude was obtained by electric telegraph time-signals, between Paris and Leiden, and is fixed at $17^m\ 56^s.60$ in time, or 4° 29′ 9″.0 E. in arc. From this longitude, that of Amsterdam, and all others have been regulated.

5. TIME SIGNALS have been established at Willemsoord for the Nieuwe Diep, at Helle-voetsluis, and at Flushing. They were placed in electric connection with the Observatory at Leiden, in September, 1859.

6. BRUSSELS.—The Observatory at Brussels was considered by the observations conducted therein, to be in latitude 50° 51′ 10″.7, longitude $0^h\ 17^m\ 29^s.0$ in time, East of Greenwich. Although this position may not affect those of the coast, which were obtained by an independent process of triangulation, yet the change in the assumed longitude of the Observatory of Paris, with corresponding alterations in the relative connexions between that and other observatories, will affect the longitudes of places on the coasts, in such a minute degree, it is true, that it is perfectly inappreciable by means at the ordinary

sailor's command; yet it is noticed here to show to what refinement these operations are carried on. It will also demonstrate the almost insuperable difficulty there is in arriving at an exact conclusion. This subject has been alluded to in connexion with the Edinburgh Observatary, and will be hereafter with that of Paris.

In 1859, a series of instantaneous electric signals was made to connect the observatories of Brussels, Berlin, Altona, &c., and the longitude of Brussels, as given by M. Quetelet, comes out as $17^m\ 28^s.9$, or 4° 17′ 30″.50 East of Greenwich—a very close approximation to the independent assumption.

The VARIATIONS OF THE COMPASS are now *decreasing* at the rate of 10′ per annum.

6.—COASTS OF FRANCE.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
NORTHERN COAST.	° ′ ″	° ′ ″	° ′	
PARIS, Imperial Observatory .....[1]	48 50 13	2 20 9	17 0	Originally from the triangles intended merely for the admeasurement of the degrees of the meridian in France, but ultimately carried on throughout the kingdom. These were commenced by M. Picard, who effected an admeasurement between Paris and Amiens in 1669, and finally completed by Messrs. Mechain and Delambre, in 1798; after having exercised the abilities and industry of M. Cassini the elder, his son, and grandson; and of MM. Miraldi and de la Caille, with other of the most eminent French astronomers, &c., to the present time.
Belgian Frontier, Corps de Garde.....[2]	51 4 55	2 31 13		
Bergues, great spire	50 58 8	2 26 20		
Dunkirk, great tower	51 2 12	2 22 33	17 10	
———, Lenguenaard Tower	51 2 28	2 22 41		
Cassel, Western Mount ..	50 48 1	2 15 48		
Gravelines, Church Spire..	50 59 10	2 7 44		
Oye, Station in Survey....	50 58 43	2 2 32		
Calais, Spire	50 57 33	1 51 9	17 40	
———, New Lighthouse ..	50 57 45	1 51 7		
Coquelles, West Mill.....	50 55 41	1 48 53		
Blanc-Nez, Guardhouse....	50 55 33	1 43 34		
Mont Couple, summit	50 52 17	1 33 11		
Gris-Nez Lighthouse	50 52 10	1 34 53		
Ambleteuse, Windmill	50 48 45	1 37 34		
Boulogne, Colonne de la Grand Armée.....	50 44 31	1 37 0	17 45	
———, Cathedral	50 43 38	1 36 53		
Cape d'Alprec'h Lightho...	50 41 57	1 33 41		
Lornel Pt. Light	50 33 38	1 34 36		
Etaples	50 30 52	1 38 30		
Touquet, South Light	50 31 43	1 35 11		
Berck, Lt. on Haut-Banc..	50 23 52	1 33 24		
Cayeux Lighthouse	50 11 42	1 30 41		
Tréport, Steeple.....	50 3 39	1 31 21		
Dieppe, St. Jacques Church	49 55 35	1 4 38	17 50	
Ailly Lighthouse	49 55 7	0 57 30		
St. Valery en Caux, Chapel	49 53 12	0 42 47		
Fécamp Abbey	49 55 22	0 21 50		
C. d'Antifer.....	49 44 17	0 9 46		
C. La Hêve, N. Lighthouse	49 30 46	6 4 4		
Le Havre, Steeple of Notre Dame	49 29 15	0 6 24	18 15	
Honfleur, Western Light..	49 25 32	0 13 38		
		Lon. W.		
Oyestreham Church	49 16 38	0 15 33		
Vierville	49 22 24	0 44 21		
St. Marcouf Is., Lightho..	49 29 55	1 8 52		
La Hougue Lighthouse ..	49 34 27	1 16 36		
Cape Barfleur Lighthouse .	46 41 50	1 16 2		

COASTS OF FRANCE—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Cherbourg, Fort Central on the Digue	49 40 28	1 37 14	19 10	
Querqueville, Spire	49 39 55	1 42 0		
Cape La Hague, Lightho..	49 43 21	1 57 21		
Alderney, East Mill	49 42 52	2 22 7	19 40	The Survey by Captain Martin White, R.N., and Mr. Richards.
Casquets, Lighthouse	49 43 22	2 22 42		
Guernsey, St. Pierre Pierhead	49 27 0	2 33 0		
Jersey; St. Helier, Victoria Pier	49 10 33	2 7 18	19 20	
Corbiere Rocks Lighthouse	49 10 40	2 14 50		
Chausey Island, Lighthouse	48 52 13	1 49 40		
C. Carteret, Lighthouse ..	49 22 27	1 48 31		
Granville, Lighthouse	48 50 7	1 36 52		The excellent Surveys of the Coast by the French Engineers, under the direction of M. Beautemps Beaupré, 1830, 1831. The account of the operations has been drawn up by M. Bégat.
CAPE FREHEL, Lighthouse	48 41 5	2 19 15	19 15	
Le Rohinet, Islet	48 40 33	2 28 53		
Cape d'Erqui	48 38 45	2 29 24		
Les Comtesses, Western Rock	48 38 58	2 34 36		
Grand Lejon (Rock)	48 45 0	2 39 58		
Harbour Isle, off St. Quay.	48 40 2	2 48 35		
Isle Bréhat, N.E. Point ..	48 51 54	2 59 21		
Héaux de Bréhat, Lighthouse	48 54 33	3 5 17		
Treguier River, La Corne Rock Lighthouse	48 51 20	3 10 40		
Les Sept Iles, Lighthouse .	48 52 46	3 29 33		
Ile de Bas, Lighthouse near the West end	48 44 45	4 1 42		
Chenal du Four, Lightho..	48 31 20	4 48 20		
OUESSANT, or USHANT, N. Lighthouse	48 28 31	5 3 31	20 25	
THE BAY OF BISCAY.				
Les Pierres Noires Lighthouse	48 18 40	4 55 0		
Lampaul	48 33 40	4 38 5		
Kermorvan, Lighthouse ..	48 21 44	4 47 31		
St. Mathieu, Lighthouse ..	48 19 49	4 47 57		
Portzic, Lighthouse	48 21 29	3 32 10		
BREST, St. Louis	48 23 20	4 28 14	20 10	
Crozon, Church	48 14 48	4 28 38		
Bec du Raz, Lighthouse ..	48 2 22	4 44 3		
Ile de Sein, Lighthouse ..	48 2 35	4 52 9		
Ar-men Rock, Lighthouse .	48 3 0	6 2 0		
Penmarc'h Lighthouse	47 47 53	4 22 36		
Penfret, Lighthouse	47 43 17	3 57 21		The HYDROGRAPHIC SURVEYS of the Western Coasts of France, made under the direction of M. Beautemps Beaupré; an exposition of which, by M. Daussy, was published at Paris, by authority, in the years 1829 and 1839.
Ile de Groix, Western Lt.-house	47 38 55	3 30 41		
Port Louis, St. Pierre	47 42 31	3 20 34		
Belle Ile, Lighthouse on S.W. Point	47 18 43	3 13 43	19 20	
———, Borderun Signal	47 21 1	3 13 55		
Ile Hœdic, Lighthouse	47 20 32	2 52 11		
Le Four, Lighthouse	47 17 53	2 38 9	19 5	
Aiguillon, Lighthouse	47 14 33	2 15 0		

COASTS OF FRANCE—Continued.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Pilier, Lighthouse	47 2 36	2 21 55		The Hydrographic Surveys.
Ile d'Yeu, Lighthouse	46 43 5	2 23 0		
St. Gilles sur Vie	46 41 46	1 55 14		
La Chaume, Lighthouse	46 29 42	1 47 50		Remarks.
Sables d'Olonne, Jetty Lt.-house	46 29 28	1 47 35		It is to be remarked, that the longitudes, as given in the *Connaissance des Temps*, compared with those in the Charts of the *Pilote Francais*, constructed between 1816 and 1827, under the direction of M. Beautemps Beaupre, showed a difference amounting to, at the least, 51″.5, the former survey being so much less, which is occasioned by the later determination of the geographical position of Crozon, near Brest, as explained in the note. The corrected longitudes are given in the table.
Ile de Ré, Baleine Light-house	46 14 44	1 33 48		
„ Port of St. Martin	46 12 26	1 33 48		
Rochelle, Harbour Light	46 9 21	1 9 30	18 20	
Oleron, Chassiron Light-house	46 2 52	1 24 47		
Isle of Aix, Harbour Light	46 0 36	1 10 48		
Point de la Coubre, Light	45 41 30	1 15 25		
Port of Royan, Light	45 37 8	1 1 54		
Cordouan Lighthouse	45 35 14	1 10 30		
Pauillac, Harbour Light	45 11 55	0 44 46		
Bordeaux, West Point of St. André	44 50 16	0 39 55	17 40	
Point de Grave, Lighthouse	45 34 29	1 3 39		
Beacons East of Capbreton	43 39 26	1 25 44		
La Tête de Buch	44 37 57	1 8 13		
Signal Tower of the River Adour	43 31 36	1 30 6		
Bayonne	43 20 26	1 27 57		
Biaritz, Lighthouse	43 29 38	1 33 40		
Socoa, Harbour Light	43 23 44	1 41 19	18 5	
St. Jean de Luz, Jetty Lt.-house	43 23 16	1 39 57		

NOTES.

Paris.—The grand operations, in point of accuracy, for the determination of the length of the degrees of the meridian, have taken place since 1783. In that year a memorial was transmitted by M. Cassini de Thury to the Right Hon. Charles James Fox, then Secretary of State. This application caused the operations by General Roy, already explained which afterwards extended into a General Survey. This gentleman, in England, acted in conjunction with Messrs. Cassini, Mechain, and Legendre, in France; but it unfortunately happened that the results of the two parties did not exactly agree—that of the British being, for the difference of longitude, 2° 19′ 51″, while that of the French was 1° 23′ 15″.

In order to determine this question, the subject was resumed in 1821, on the suggestion of the French authorities. The operations were consequently repeated under the direction of commissioners, nominated respectively by the Academy of Sciences and the Royal Society. An account of the operations and results have been given in the "Transactions', of the latter, and the determination was that 2° 20′ 22″ is the difference between the meridians of Paris and Greenwich. It was also attempted in 1825, by the respective governments on a plan suggested, we believe, by the late Sir John Herschel, and Captain (now General Sir Edward) Sabine, and Colonel Bonne, of Simultaneous observations of rocket signals at a chain of stations; but they failed on the French side, and the result, 2° 20′ 22″, was not considered satisfactory.

Notwithstanding the immense labour and consummate skill employed in these measurements, the results obtained were doubtful, and it was reserved for the private means of a

commercial association to settle the question by means of the electric telegraph. The death of M. Arago, delayed the French preparations which were organized when M. le Verrier became Superintendent of the Paris Observatory, and several thousand signals were transmitted in 1854, so many, in fact, that a large portion were rejected, leaving 1,700, or nearly 2,000, which were thought unexceptionable. Each observation is probably as accurate as the mean of all former observations, and the means of all show previous results to be in error nearly a second of time (a large quantity in astronomy), and which, corrected, is nearly certain to its hundredth part.

The mean result of these final electric observations, is that the D.L. between Greenwich and Paris Observatories, is $9^m\ 20^s.63$ of time, or $2°\ 20'\ 9''.45$ in arc.

We have been more diffuse, perhaps, than necessary on this point, but it is perhaps the most important geodetical operation ever undertaken.

2. The re-examination of the northern coasts of France and the triangulated Survey of the western shores was originated in 1814, by a memorial addressed to Louis XVIII. by Admiral Rosily, and Admiral Rossel, but from political events it was not commenced till 1816, and then Beautemps Beaupré started the survey from Brest. The triangulation was based upon the carefully observed position of the Tour de Crozon, and carried out by M. Daussy down to the frontiers of Spain. The noble Atlas, afterwards completed, is the best eulogy that can be presented for these important works.

The VARIATION OF THE COMPASS is *decreasing* at the rate of about 7′ 30″ per annum.

7.—COASTS OF SPAIN AND PORTUGAL.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
NORTH COAST OF SPAIN [1]	° ′ ″	° ′ ″	° ′	
Cape La Higuera, Lightho.	43 22 35	1 46 58	18 5	The valuable surveys of Don Vicente Tofiño, and Don Josef Varela, of the Spanish Marine, and of Major Franzini, of the Portuguese Royal Engineers, corrected by later observations of M. Saulnier de Vauhello, Captain Florez, Captain W. H. Smyth, R.N., and others.
Fuenterrabia	43 21 46	1 47 0		
Port Pasages, Cape La Plata Lighthouse	43 20 21	1 56 33		
San Sebastian, Mt. Igualdo Lighthouse	43 19 28	2 0 26	18 15	
Guntaria, Atalaya or Tower	43 18 50	2 12 30		
Motrico, Atalaya	43 20 0	2 24 25		
Cape Machichaco, Lighthouse	43 28 0	2 49 26		
Punta Galea, Lighthouse	43 22 36	3 4 2		
Portugalete	43 20 0	3 3 0		
Bilbao, Bridge	43 15 10	2 55 25	18 25	
Castro Urdiales, Santa Ana Castle Light	43 24 10	3 16 6		
Santona, Light building on Mount	43 27 30	3 16 40		
Cape Ajo, extreme	43 32 0	3 26 25		
Santander, Mouro Island Lighthouse	43 28 37	3 45 43		
Cape Mayor, Lighthouse	43 30 15	3 47 6	18 45	
San Martin de la Arena, Suances Church	43 26 10	4 0 35		
Cape Oyambre, extreme	43 25 30	4 20 55		
San Vicente de la Barquera, Lighthouse	43 23 30	4 25 10		
Llanes, San Pedro Point	43 27 30	4 45 40		
Cape Prietro, extremity	43 28 48	4 50 40		

COASTS OF SPAIN AND PORTUGAL.—Continued.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Sella R., East point near Rivadesella	43 31 0	5 6 0		The Charts publishen by the Spanish Government, &c.
Cape Lastres	43 33 20	4 17 45		
Gijon, Sta. Catalina Point Lighthouse	43 35 13	5 38 2	18 50	
„ Cape Torres	43 37 0	5 39 0		
Cape Peñas, Lighthouse	43 42 20	5 50 20	19 25	
Aviles, R. Forçada Point	43 38 30	5 56 0		
Cudillero, Revallera Point Light	43 36 10	6 9 3		
Cape Bidio, extreme	43 38 0	6 15 0		
Cape Busto, Lighthouse	43 36 10	6 28 48		
Ria de Navia, Campel Pt.	43 34 30	6 44 20		
Orrio de Tapia Island, Lighthouse	43 35 36	6 58 26	20 10	
Rivadeo, Pancha Island Lighthouse	43 34 40	7 4 15		
Foz, Point de los Cairos	43 35 25	7 16 0		
Port Vivero, Socastro Pt.	43 43 28	7 37 40		
Estaca Point, Lighthouse	43 47 30	7 43 24		
Cape Ortegal, extreme	43 46 10	7 56 50	21 15	
Candelaria Point, Tower	43 41 56	8 3 0		
Cedeira, Point Pantin	43 40 48	8 6 5		
Cape Prior, Lighthouse	43 33 40	8 19 9		
Cape Priorino, Lighthouse on the Little Cape	43 27 50	8 20 33		
Ferrol, West Mole [2]	43 28 35	8 14 25		
Coruña, Tower of Hereules Light	43 23 0	8 24 8	20 50	
„ St. Antonio Castle	43 22 0	8 22 5		
Sisargas Island, Lighthouse on I. Mayor	43 21 50	8 50 13		
Cape Villano Lighthouse	43 9 50	9 12 58		
Camarinas, Mole	43 8 0	9 10 40		
West Coast of Spain.				
Cape Toriñana, extreme	43 4 30	9 17 15		
Cape Finisterre, Lighthouse on South extreme	42 52 39	9 15 24	21 15	
Corcubion, Lt. on Cape Cé	42 54 50	9 10 8		
Remedios Point, extreme	42 47 45	9 7 35		
Muros Bay, Lourp Mount on North side	42 44 30	9 3 30		
Cape Corrobedo, Light	42 34 38	9 4 48		
Falcociro Point, extreme	42 31 0	9 1 3		
Arosa Bay, Sta. Eugenia Church	42 33 0	9 57 57	20 55	
„ Salbora Island. Light on South point	42 27 50	9 0 23		
„ Carril Church.	42 36 40	8 45 0		
„ Arosa Island, Light on North point	42 34 8	8 51 58		
Onza Island, Galera Point	42 20 7	8 54 30		
Pontevedra Bay, Cape Udra	42 20 0	8 48 50		
„ Pontevedra, centre	42 25 30	8 37 20		

COASTS OF SPAIN AND PORTUGAL.—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Bayona or Cies Islands, Caballo, or North Point ..	42 14 50	8 53 25	21 0	The Charts published by the SPANISH GOVERNMENT, &c.
„ Middle Island, Light on Mount Faro ..	42 12 2	8 54 6		
Bayona Is., Boeiro Island, off South end	42 10 12	8 52 56		
Vigo Bay, Cape Hombre, rock off	42 14 45	8 50 40		
„ Vigo, Castro Castle..	42 13 35	8 41 30	20 55	
„ N.S. de la Guia Castle Light.....	42 15 6	8 41 2		
Vigo Bay, Cape Sentoulo, Mount Ferro	42 8 50	8 49 0		
Bayona Church	42 6 45	8 49 0		
Cape Silleiro, extreme....	42 6 0	8 52 7		
Orullada Point, extreme ..	42 1 0	8 53 0		
Minho River, Mount St. Tecla Chapel	41 5 50	8 49 25		
COAST OF PORTUGAL.				
River Minho, Castillo Pt...	41 50 6	8 48 30	20 50	
Viana, Castello de Santiago	41 41 25	8 43 45		
River Neiva, entrance	41 37 30	8 42 0		
Esposende	41 37 0	8 39 30		
Villa do Conde	41 21 30	8 35 0		
River Douro, Light at N.S. De Luz .....[3]	41 9 9	8 37 10		Capt. Sir Edward Belcher, R.N., 1833.
Oporto, San Joao de Foz ..	41 8 48	8 37 0	20 30	
Aveiro, Town.....	40 38 0	8 39 30		
Cape Mondego Lighthouse	40 12 0	8 55 12		
Peniche, Lighthouse on Cape Carvoiero	39 21 8	9 24 16		
Berlengas, Light on Great Island	39 25 0	9 30 17	20 10	
Farilhoens, centre	39 29 0	9 31 56		
Cape Roca, Lighthouse ..	38 46 6	9 30 0		
Tagus River, Bugio Fort Light	38 39 0	9 18 9		
LISBON, Observatory [4]	38 42 25	9 7 32	20 0	
Cape Espichel, Lighthouse	38 24 9	9 13 0		
Setuval or St. Ubes, Light on Fort d'Outao.....	38 31 9	8 53 0		
Cape Sines, Fort	38 0 0	8 51 30		
Cape Sardao	37 31 30	8 49 0		
Cape St. Vincent, Convent Light	37 2 54	9 0 54	19 30	
Gorringe or Gettysburg Bank, shoalest spot	36 31 30	11 35 30		
Lagos, principal Church ..	37 8 40	8 37 45		
Piedade Point	37 6 54	8 37 30		
Villa de Nueva de Pontiñao	36 7 30	8 31 10		
Baliera Point	37 3 0	8 14 0		
Cape Santa Maria, Light..	36 56 0	7 46 0		

COASTS OF SPAIN AND PORTUGAL.—Continued.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
South Coast of Spain.				
	° ′ ″	° ′ ″	° ′	
Guadiana River, Ayamonte Mouth	37 11 0	7 18 0	18 40	The Charts published by the Spanish Government, &c.
Odiel River, Lights for Huelva	37 13 22	6 51 34		
Guadalquiver River, Pta. de Malandar Light	36 47 20	6 21 53		
San Lucar de Barrameda, great Church	36 45 5	6 22 10		
Chipiona, Church Tower Light	36 44 15	6 25 46		
CADIZ, San Fernando Observatory [5]	36 27 45	6 12 16	18 30	
——— San Sebastian Castle	36 31 10	6 18 54	18 30	
Cape Trafalgar, Tower on West side	36 10 45	6 2 12		
Pta. Gracia, Tower	36 5 5	5 49 58		
Mt. Sella del Papa, summit (1567 feet)	36 6 16	5 46 20		
Pt. Paloma	36 36 20	5 42 40		
Tarifa, Lighthouse on South point	35 59 47	5 36 45		
Pta. Acebuche	36 2 48	5 28 15		
Carnero Tower	36 4 30	5 25 50		
Algesiras, Vete I. Light	36 7 15	5 26 16		
Gibraltar, New Mole Light [6]	36 7 20	5 21 32	18 5	
Europa Point, Victoria Lighthouse	36 6 22	5 21 0		

NOTES.

1. The North Coast of Spain.—The whole of the North coasts of Spain were excellently surveyed and delineated by Don Vincente Tofiño de San Miguel in the years 1787-91; at the same period that our hydrography was being enriched by the talent and labours of Mackenzie, Spence, and others. The Spanish charts, still most useful, exhibit the minute details of this ironbound coast with such fidelity, that but little change has been found necessary upon a re-examination. This, doubtless, is in some degree owing to the geological structure of the country, which, devoid of sloping beaches, presents a much more effective barrier to the degrading action of the sea, while the South-west Coast of France at the bottom of the Bay of Biscay, is embarrassed by these immense collections of sand, &c., the debris of the coasts to the West of it, which is carried thither by the prevalent wind-waves and currents.

But while the details of this survey are so excellent, later, and more correct observations show that there are some great errors in the relative position of the principal points. This was detected, among other operations, by the early observations of M. Bory, and perhaps by the Spanish Surveys, which were taken possession of by the French, at the investment of Madrid. Later, the survey made by M. Saulnier de Vauhello, of the French Marine, showed that Cape Machichaco was placed nearly 10′ too far eastward, and other points from 4′ upwards, also too far to the East. These great errors are now, if not entirely removed, so nearly adjusted, that the discrepancies are too small to affect naviga-

tion. The positions, especially the longitudes, given in the table, are in accordance with the charts published by the Deposito Hidrogràfico at Madrid in 1846.

2. Coast of Galicia.—The North-west coast of Spain was re-examined by Captain Don J. F. Florez, of the Spanish Navy, in 1835-6. His survey seems to show the accuracy of his predecessor Tofiño. The positions of Captain Florez have been followed.

3. River Douro.—This river was surveyed by Commander (afterwards Sir Edward) Belcher, R.N., in 1833. His determinations, which coincide with those made by Admiral Smyth, when a lieutenant, in 1811-12, serve to correct the positions previously given by Tofiño. In former editions of this work, we had to acknowledge our obligations in this, as in many other instances, to Admiral Smyth, for his improvements in hydrography. It is sufficient here to repeat them.

4.—Lisbon.—The longitude of Lisbon had been previously assumed as 9° 8′ 40″, being a mean result of observations made by the astronomers De la Caille, Pingré, and Messier, according to a great number of eclipses of the first satellite of Jupiter. The occultation of a star by the moon, October 5, 1753, with a corresponding one at Paris, gave one minute more. Captain Fitzwilliam Owen, in the memoir of his important expeditions to Portugal and Africa, assigns to the Arsenal of Lisbon 38° 42′ 18″ N., and 9° 8′ 54″ W., from observations made in H.M.S. *Leven*, in 1819 and 1822. It is now considered to be 9° 7′ 31″.8 W.

5.—Cadiz.—The position of the Observatory in the city of Cadiz is established as 36° 32′ 0″ N., and 6° 17′ 30″ W. The New Observatory (*Real Observatorio*) of San Fernando, in the Isle of Leon, is in 36° 37′ 43″ N., and 6° 12′ 16″ W.

6. Gibraltar, &c.—Mr. Charles Rumker gives the position of Europa Point, Gibraltar, as 36° 5′ 15″ W.—(*Edinburgh Philosophical Journal*, vol. i. p. 322.) Captain Bauza, of the Hydrographic Establishment at Madrid, gave Tarifa in 36° 0′. This accords with Mr. Rumker; but Captain Livingston made the latitude of Europa Point, by sextant and artificial horizon, in 1820, 36° 6′ 10″, and exactly the same on another day, by the sea horizon. Captain Smyth has given Gibraltar in 36° 6′ 30″, and 5° 21° 12″.

It is to be observed that Lieutenant Raper adopts 5° 21′ 17″ as the longitude of the Mole (or Europa Point in 5° 22′ 0″), and this is from the observations of Captain Smyth; Captain Shirreff, 5° 20′ 16″; and Captain Vidal, 5° 21′ 42″. This position is important, as it affects longitudes of the West Coast of Africa.

The variation of the compass is *decreasing* at the rate of from 5′ in the S.W. portions of the coast, to 6′ or 7′ per annum in the Eastern parts.

8.—COAST OF AFRICA.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Ceuta, Almina Point Light	35 53 38	5 17 3	18 0	Capt. C. P. de Kerhallet and M. C. A. Vincendon-Dumoulin.
Sierra Bullones or Apes Hill (summit)	35 53 35	5 25 0		
Tangier Bay, Cape Malabata, tower	35 48 50	5 45 12		
Tangier, N.E. part of town	35 47 5	5 48 40		
Cape Spartel, Pitch....[1]	35 47 0	5 56 0		
Arzilla	35 29 30	6 0 0		Capt. (aft. Adm.) Washington and Lieut. Smith, R.N., 1830.
El Araiche	35 12 50	6 9 0	18 25	
Old Mamora	34 52 30	6 25 0		Capt. T. Boteler, R.N., 1828.
Mehedia	34 18 0	6 36 0		Capt. Washington, R.N., 1830.
Faz or Fez	34 6 3	4 58 15		Don Juan Badia y Leblich, otherwise called Ali Bey, 1804.
Mekinez	33 58 30	7 30 0		
Slaa or Salee	34 2 45	6 45 30		
Rabat	34 2 30	6 46 0		Captains Boteler and Washington, 1828 and 1830.
El Mansoria....[2]	33 46 10	7 20 0		

COAST OF AFRICA—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Point Fidallah	33 44 0	7 23 32		Capt. Washington and Lieut. Smith, R.N., on the Mission to Morocco, 1829, 1830, and the Survey of Lieutenants William Arlett & H. Kellett in 1835.
Dar-el-Beida	33 36 30	7 35 24		
Azamor	33 17 37	8 15 0		
Mazagan.....	33 15 0	8 29 0		
Cape Blanco, North	33 8 0	8 38 0	18 35	
El Waladia	33 48 0	8 48 0		
Cape Cantin	32 32 27	9 14 50		
Asfee or Saffi.....	32 18 15	9 12 0		Capt. T. Boteler, R.N., 1828.
MAROCCO, centre .....[3]	31 37 0	7 36 0	17 50	Don Juan Badia and Captain Washington.
SUERRAH or MOGODOR....	31 30 30	9 46 0	18 40	
Cape Tefelneh	31 4 0	9 47 30		Lieut. Arlett.
Cape Ghir or Geer.....	30 38 0	9 53 0		Capt. T. Boteler, 1828.
Ras Aferni	30 37 20	9 52 0		The Chevalier de Borda, 1776.
Agadir or Santa Cruz	30 26 35	9 35 56		Observations of Lieuts. Arlett and Kellett, R.N., 1835.
Cape Aguluh	29 49 0	9 48 0		
Cape Nun or Inoon	28 45 45	11 4 10		
Porto Cansado, entrance ..	28 2 0	12 14 0		
Cape Juby	27 57 50	12 51 0		
False Cape Boiador	26 25 15	14 12 30		Lieut. Arlett, &c., 1835.
Cape Boiador or Bojador [4]	26 7 2	14 30 34	19 0	
Penha Grande, summit....	25 7 6	14 50 53		
Seven Capes, Central Cape	24 41 12	15 0 30		
Angra dos Cavallos	24 8 12	15 36 18		The Observations of Capt. W Fitzwilliam Owen, and those of M. le Baron Roussin.
Rio do Ouro, or Gold River, entrance, North point ..	23 36 18	15 58 30		
Cintra Bay, North point .	23 7 0	16 9 15		
,, South point ..	22 56 36	16 14 10		
Cape Barbas	22 19 30	16 39 12		*** In 1830, Captain (aft. Adm. Sir Edw.) Belcher, by repeated observations, found Cape Blanco in lat. 20° 46′ 26″, long. 17° 4′ 10″.
Pedra da Gall, centre	22 12 30	16 48 4		
Cape Corvoeiro .	21 46 44	16 56 40		
Cape Blanco .	20 47 0	17 4 36		
Cape Mirik, the Down...	19 25 0	16 32 0		H.M.S. *Esk*, Captain Purchas, 1826.
Tanit Bay, the Down	19 3 48	16 12 20		
Angel's Hillocks, Southern	18 29 30	16 2 0		
The Two Palm Trees Portandik .....[5]	18 18 54	16 2 12	19 10	Latitudes, Capt. Roussin, Longitude inferred by Chart, and *uncertain*.
Down of Red Sand	17 25 0	16 12 0		
Second ditto	16 55 0	16 25 0		
Huts of Inguagher	16 35 24	16 30 0		
St. Louis, Senegal, Lighthouse on Government House	16 0 48	16 31 1	19 25	Captain (afterwards Admiral and Baron) Roussin, in the years 1817 and 1818.
Bar of the Senegal, North Point	15 55 18	16 30 0		
Little Paps, near Cape Verde, northern one	14 56 24	17 4 30		
CAPE VERDE, extremity ..	14 44 30	17 32 0	19 35	Capt. Roussin and M. Givry.
Almadie Rocks, off Cape Verde, highest and westernmost	14 44 29	17 33 30		Capt. Fitzwilliam Owen.
Gorce, the Fort Lighthouse	14 39 50	17 24 30		
Cape Naze	14 31 30	17 7 20		Capts. Owen and Boteler.
Portudal, Village	14 27 18	17 3 12		Capt. W. F. Owen, R.N., 1824.
Point Serine	14 18 0	16 56 30		Capt. T. Boteler, 1829.
Joal, Town.....	14 10 0	16 49 45		Capts. Owen and Boteler.

COAST OF AFRICA—Continued.

	LAT. N.	LONG. W.	VAR. WEST, 1878·9.	AUTHORITIES.
River Gambia—	° ′ ″	° ′ ″	° ′	
Bathurst Town, Flagstaff	13 28 0	16 35 18	19 34	Survey of the River Gambia, from its entrance to Pisania, by Captain Richard Owen, R.N., assisted by Messrs. E. O. Tudor and S. M. Mercer, 1826.
Bird Island, Flagstaff	13 39 12	16 40 30		
Cape St. Mary	13 30 12	16 41 24		
James Fort	13 9 40	16 22 12		
Thankrowell	13 25 0	16 3 48		
Elephant Isle, West Pt.	13 26 20	15 20 36		
Yamamaroo Town	13 42 0	14 58 30		Survey of the River Gambia, &c.
M'Carthy's Isle, Fort George	13 33 0	14 45 30		
Pisania or Pisaneca	13 31 54	14 34 18		
Bald Cape	13 22 30	16 49 20		
Point St. Pedro	13 7 15	16 48 0		
River Souta, Bird Islet	12 43 30	16 49 0		Capt. Thos. Boteler, in H.M. sloop *Hecla*, 1829.
River Casamanza, N. Point of the entrance	12 35 20	16 48 0		
Cape Roxo	12 21 0	16 44 40		
Breakers of Falulo, West Point	12 5 0	16 38 30		Capts. Roussin & W. F. Owen, 1818, 1821, 1826.
Isle of Cayo, South Point	11 49 50	16 20 0		
Bissao, Portuguese Fort	11 51 0	15 37 6	19 42	
Bijooga Islands, &c.				
Papakawa Islet	11 36 30	15 54 12		
Arcas Isle, centre	11 41 51	15 39 0		
Bolola Town, Rio Grande	11 35 0	15 2 18		Survey of the Bijooga Islands, and the adjacent Coast of Africa, by the officers of H.M.S. *Leven*, Capt. W. F Owen, 1826.
Bulama Island, East end	11 34 42	15 30 24		
Bossessamé, or Tombelly, North Point	11 29 0	15 30 0		
S.W. point	11 19 24	15 32 12		
Gallinha Isle, West Point	11 27 42	15 46 30		
N.E. Hog Island, East Point	11 20 0	15 40 42		*** In 1830, Capt. (Sir Edw.) Belcher, in H.M.S. *Etna*, from his observations, made Pullam Island, S. end, in 10° 51′ 53″ N., and 15° 43′ 5″ W.; the North end of Alcatraz, in 10° 38′ 1″ N., and 15° 20′ 30″ W. Sandy Isle in lat. 10° 36′ 31″ N., and 14° 42′ 19″ W.—*Geo. Journal*, vol ii., pp. 284, 291, 295.
Kanyabac, N.E. Point	11 18 4	15 43 3	19 40	
„ S.W. Point	11 10 12	15 48 12		
Orango, S.E. Point	11 3 12	15 55 12		
„ West Point	11 6 0	16 15 30		
South Breaker	10 56 18	15 57 40		
Pullam Island, South Point	10 51 12	15 45 6		
Alcatras Island, centre	10 37 12	15 26 30		
Conflict Reef, centre	10 30 0	15 11 0		
Rio Nunez; Entrance, Sand Isle	10 36 37	14 42 0		Capt. (now Sir E.) Belcher.
Rio Nunez; Rebucko Town	10 57 0	14 21 48		Lieut, Austin, in the *African*, 1827.
Cape Verga, summit	10 11 40	14 28 5		
Pongas River, entrance	10 2 0	14 6 0	19 35	
Mount Kakulimah	9 45 0	13 28 0		Captain (Sir Edw.) Belcher.
Isle de Los:—				
Crawford Isle Establishment	9 27 24	13 48 30		
Tamara, Arethusa, or N. Point	9 31 0	13 40 30		
————, West Point	9 26 30	13 51 30		
Matacong Island, centre	9 14 0	13 25 30		Captain W. F. Owen, in the *Leven*, 1826; confirmed by
Yelleboa Island, centre	8 55 42	14 17 45		

COAST OF AFRICA—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Parrot Island, centre	8 53 0	13 15 0	19 35	himself in the *Eden*, and by Captain Purchas in the *Esk*, 1827.
CAPE SIERRA LEONE; extremity, Lighthouse..[6]	8 30 0	13 17 35		
SIERRA LEONE, King Tom's Point	8 30 6	13 14 30		
———, Freetown, Citadel	8 29 42	13 14 18		
False Cape, extremity	8 25 48	13 17 48		
Cape Chilling, or Shilling	8 9 30	13 10 12		
Banana Isles, highest peak	8 5 48	13 16 12		
———, West Point	8 5 0	13 15 12		
Plaintain Islands, Gillmorris	7 55 12	13 3 12		
——— ———, Bengal Rocks	7 54 36	13 2 48		
Tassa, extreme point	7 55 30	13 2 12		
Turtle Isles; North Island, centre	7 40 48	13 4 18		
Cape St. Anne, extremity	7 34 0	12 57 0	19 37	
Shoals of St. Anne:—				Captain W. F. Owen, in the *Leven* 1826.
Northern extremity	7 56 0	(Not ascertained)		
Southern extremity	7 31 30			
Western limit	7 38 0	13 29 0		
York Isle, in Sherbro' River, Huts	7 32 0	12 26 42		
Shebar, Sherbro' River	7 22 48	12 31 30		
Boom Kittam River, Forks	7 14 24	12 8 36		
River Galinhas, entrance	7 0 1	11 38 5		Capt. A. T. E. Vidal, in H.M. ships *Etna* and *Raven*, 1835 to 1839.
Cape Mount (1,046 feet), Western Beach	6 43 0	11 21 9	19 35	
St. Paul's River, entrance	6 22 0	10 37 0		
CAPE MESURADO, extremity (Lighthouse)	6 19 15	10 49 0		
Monrovia, Govt. House	6 19 5	10 48 55	19 35	
Junk River; Marshall, an American Settlement, Agent's House	6 8 6	10 22 45		
Bassa, Director's House	5 54 50	10 4 5		
River Sestros, or Grand Cestos, South entrance	5 26 25	9 34 45		
Baffou Point	5 9 10	9 17 30		
Bloe Bara, or Barbarra Factory, Sinou	4 59 15	9 2 5		
Middle Neefoo, or Niffou	4 45 3	8 32 2		
CAPE PALMAS, Lighthouse	4 22 9	7 44 16	19 34	
Tahou	4 24 47	7 21 30		
Grand Bereby	4 39 3	6 54 30		
St. Andrew's River, King George's Town, within Swarton Corner	4 57 8	6 3 47		
Jellacottee	5 51 0	5 52 20		
River Fresco, or Rio de Lagos, off the Mouth	5 1 8	5 32 5		
Grand Lahou	5 8 3	4 57 40		
Jack Jaques	5 11 8	4 26 8		
Assinee River, Anchorage S.E. of the Mouth	5 3 5	3 12 7	19 10	
Apollonia	4 58 45	2 35 5		
Fort St. Anthony	4 52 18	2 14 45		

COAST OF AFRICA—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Cape Three Points.....	4 44 30	2 5 45		
Acquidah	4 45 27	2 2 8		
Dixcove	4 47 45	1 56 40		
Elmina, or St. George del Mina	5 5 0	1 22 30		
CAPE COAST CASTLE:—				
Southern Turret, Timeball	5 5 25	1 12 5	19 0	George Maclean, Esq.
Maurce, or Morce, Flagstaff	5 7 30	1 12 0		Capt. W. F. Owen, in the *Eden*, 1827; and Captain Purchas, in the *Esk*, same year.
Annamboe, Flagstaff.....	5 10 12	1 7 12		
Cormantine, Flagstaff	5 10 30	1 5 36		
Tantumquerry, Flagstaff ..	5 13 30	0 46 48		
Tantumquerry, Extreme Point	5 12 30	——		*Long. of Accra*, by 4 good chronometers of H.M.S. *Dryad*, Capt. Hayes, in Feb. 1832, 0° 15′ 20″ W., lat. 5° 32′ 27″ N.
Devil's Hill, summit.....	5 18 36	0 39 0		
Barracoe, Point	5 29 0	0 24 0		
Accra, British flagstaff	5 32 0	0 11 30 East.	19 10	Captain Vidal.
Ningo, Fort	5 45 0	0 1 48		Captains Owen and Purchas.
Volta River, entrance	5 47 18	0 42 18		Capt. Kelly, in the *Pheasant*.
Cape St. Paul.....	5 44 30	0 52 18		Captains Owen and Purchas.
Quitta, flagstaff	5 54 36	0 54 18		Captain B. M. Kelly.
Padiana, Town	5 57 42	0 57 18		Captain Purchas.
Little Popoe, Road	6 10 0	1 36 0		Captain B. M. Kelly.
Grand Popoe, Road	6 19 0	1 46 0		
Whydah, or Ajudah	6 19 30	2 5 0		
Appee	6 22 0	2 25 0		
Porto Novo; Hill	6 20 2	2 34 0		
„ „ Road	6 19 0	2 34 0		
Badagry, Mount	6 24 0	2 43 30		
„ Road	6 20 0	3 47 48		
Lagos River, entrance	6 24 0	3 22 0	18 20	
Lagos River, End of the Sandy Beach	6 20 0	4 27 0		
Benin River, N.W. Point..	5 43 0	5 4 0	18 20	Captain Vidal.
Rio dos Esclavos	5 34 0	5 5 48		Captain Purchas.
Terra Formosa, West point	4 28 0	5 41 30		Capt. A. T. E. Vidal, in H.M. sloop *Barracouta*, 1826. (*Longitude of the Bar of the Quorra, Captain William Allen*, 1833.)
Terra Formosa, Eastern pt.	4 19 24	5 54 33		
River Nun or Quorra, the Bar (2 *fathoms*) ....[7]	4 15 0	5 55 0		
Rio Bento or Second River	4 17 0	6 15 0		
Rio St. Nicolas, or Third River	4 18 0	6 24 0		Captain Vidal, in the *Etna*, and Captain Purchas, in the *Esk*, 1827; and Capts. Vidal and Boteler, 1826.
New Calabar River, Foche Point	4 22 40	7 0 0		
Bonny River, Rough Corner	4 23 40	7 7 0	18 15	
Old Calabar River, Tom Shot's Point, West of the Entrance	4 36 0	8 19 0		
Backasey Gap, East of the Entrance	4 29 0	8 32 0		
Bimbia Isle.....	3 57 0	9 13 48		
Cape Camaroens.....	3 53 0	9 0 0		
Camaroens Mountain, peak	4 13 0	9 12 0	17 50	

COAST OF AFRICA—CONTINUED.

	LAT. N.	LONG. E.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Rumby Mountains, highest peak	4 57 0	9 18 0		
Qua Mountain	5 15 0	8 51 0		
Corisco Island, N.W. point	0 55 54	9 19 45		
Cape Esterias	0 37 48	9 21 0		
Point Clara	0 30 30	9 20 30		
Cape St. John	1 9 40	9 21 35		
Gaboon River, Round Corner	0 18 5 South.	9 20 0	18 50	
Cape Lopez	0 36 12	8 45 17		
AFRICAN ISLANDS.				
FERNANDO PO:—	North.			
Clarence Peak	3 35 0	8 46 30		Captain Vidal.
Cape Bullen, Northern Extremity	3 47 25	8 39 24		
Adelaide Islet	3 34 48	8 47 17	17 52	
Point William, Flagstaff	3 45 36	8 47 0		Captain W. F. Owen, in the *Eden*, 1827.
Cape Horatio, N.E. Extremity	3 46 15	8 54 24		
Cape Vidal, E. Extremity	3 39 18	8 56 18		
Cape Barrow, S. Rock	3 11 30	8 40 0		
Cape Eden, S.W. Extr.	3 15 30	8 25 6		
Cape Badgley, W. Extr.	3 19 42	8 24 42		
Charles' Folly, N.W. Ex.	3 26 48	8 27 42		
Goat Isle, Centre	3 31 0	8 32 48		
PRINCES' ISLAND, the Brothers near	1 23 0	7 19 48	18 40	Captains Purchas and Kelly.
ST. THOMAS'S ISLAND:—				
Cabrita Isle	0 27 0	6 45 0	19 10	
Anna de Chaves, Road	0 25 30	6 46 0		
Rolas' Isle (*on the Line*)	0 0 0 South.	6 36 30		H.M.S. *North Star*.
ANNOBON; East Point	1 25 6	5 42 48	20 0	Captain Purchas.

NOTES.

1. CAPE SPARTEL.—The remarks of Mr. William Chapman, master of H.M.S. *Illustrious*, appear to confirm the longitude of Tofiño, from whom he differs only 40 seconds in latitude, which he represents as so much more to the southward. The observations of Capt. Smyth give the lat. 35° 47′ 15″, and the long. 5° 55′ 45″, by chronometer and lunars, as shown in the table. The coast, from Cape Spartel to Cape Bojador, was surveyed in the *Etna* and *Raven*, under Lieuts. Arlett and Kellet, 1835, as afterwards noticed.

2. EMPIRE OF MAROCCO.—The points determined by Captain Washington we owe to an excellent paper, entitled "*Geographical Notice of the Empire of Marocco*; by the late Lieutenant (afterwards Rear-Admiral) Jno. Washington, R.N.," given in the first volume of the "*Journal of the Royal Geographical Society*," 1831; a communication replete with interesting and useful information. Captain Washington became Hydrographer to the Navy.

3. City of Marocco.—The scientific traveller, *Don Juan Badia y Leblich*, commonly called *Ali Bey*, from his observations in 1803-4, gave the centre of Marocco as in 31° 37′, and 7° 35′ 30″. On reference to the Astronomical Journal of Captain Washington, there appear upwards of 100 sights for determining the longitude of the city. Distances between moon and sun; moon and stars East and West of her; and altitudes of the moon when in the prime vertical—the mean results of which give the longitude of a garden at the S.W. angle of the city: long. 7° 36′ W., lat. 31° 37′ 20″; mean of about 20 meridian altitudes of the sun.

4. Cape Geer, &c.—M. le Chevalier Jean Chas de Borda was charged, in 1776, by Louis XVI., with a commission to the Canary Islands and the coast of Africa, for the express purpose of making observations, and determining the chief points of the Canary Islands, &c. He was furnished with time-keepers, by which he ascertained the positions, as they have appeared in different Charts and Tables. On this expedition, M. de Borda, in the ship *La Boussole*, was accompanied by the *Espiegle*, M. le Chastenet Puysegur, who afterwards composed the Pilot for St. Domingo; also by Captain Don Josef Varela, and another intelligent officer of the Spanish marine; all of whom assisted in the operations.

But in the years 1817-18, Captain (afterwards Baron) Roussin was employed by the French Government in surveying the coast between Cape Bojador, in 26° 7′ N., and the Isles de Los, in 9½°; and this officer has given, most satisfactorily, many points not before ascertained.

Again, in 1820 and 1821, Captain William Fitzwilliam Owen, in H.M.S. *Leven*, was commissioned by the British Admiralty to examine and settle the coast from Cape Noon southward; and his observations have still further, and in a much more important degree, tended to perfect the hydrography of Western Africa. To Captain Owen's work, therefore, we refer most particularly in the Tables; and have only to add that there is a remarkable coincidence, in general, in the results of the two commanders; and that even in comparing either with those of M. de Borda, the differences, practically considered, are of little moment.

A survey of the Canary Islands, and the continental coast thence northward to Cape Spartel, was made by Lieutenants William Arlett and H. Kellett, commanders of the *Etna* and *Raven*, in 1835; the particulars of which are given in the "Journal of the Royal Geographical Society," vol. vi., 1836, and from these we derive the positions given in the Table, as more fully shown hereafter.

5. Portandik.—The two palm trees are the first seen in sailing hither from Cape Bojador. Portandik is supposed to have been situated about a mile to the southward of this spot, but not a vestige of it remained in 1818, when it was visited by Captain Roussin. It has been ceded to France, in exchange for Albreda, on the Gambia.

6. Sierra Leone, &c.—In preparing former editions of this work, we collected a large number of observations, which had been made, from time to time, on the coast of Guinea, &c., between Sierra Leone and Cape Lopez; they included those previously given by the officers of H.M. ships *Argo*, *Amelia*, *Inconstant*, *Tartar*, and others, and we finally appended to such as we selected for the tabular statement the following remarks:—"Although we have paid the utmost attention in the comparison of different results, charts, and descriptions, as shown in the tables and notes, we are by no means satisfied with the conclusions as to many points eastward of Cape Palmas and St. Andrew's Bay. Indeed, all that has yet been done by the naval officers, and others, prove only the necessity of a new series, in order to establish so much as may be correct, and to rectify so much as may not be so." Happily, such rectification has taken place, and many doubts, even on the most important points, have recently vanished.

We give a specimen, on the longitude of Cape Sierra Leone. Many years ago, the late Sir George Young gave the longitude of this Cape as 12° 33′ 47″; the French tables afterward, as 12° 34′; the requisite tables, 13° 9′ 17″; H.M.S. *Argo*, 1802, as 13° 12′; the *Inconstant*, 1816, the same; the *Amelia*, in 1812, 13° 17′ 30″; the *Leven* (Captain Owen), in 1826, 13° 18′ 0″; the *Eden* (Captain Owen), in 1827, 13° 0′ 10″; Captain Sabine, Royal Artillery,

in 1822, 13° 19′ 0″; and Captain Purchas, in 1827, 13° 19′ 12″. Hence we adopt Captain Owen's longitude, as given in the table. It may be added, that Lieutenant Raper assumes the North Battery to be in 13° 14′ 30″, or nearly as in the table.

By 318 lunar distances (23 sets), taken in the West Bastion of Fort Thornton, at Freetown, Captain Sabine, in 1822, made the longitude of that spot 13° 15′ 11″ W.; and in 1827, Captain Owen, in the *Eden*, made that of the Victualling Office 13° 14′ 30″. Latitude of the latter, 8° 30′ 6″; of Fort Thornton, by Captain Sabine, 8° 29′ 21″.

"*Fort Thornton* stands on the highest ground in its own immediate neighbourhood, excepting a small hill, on which a martello tower is built, at a distance rather exceeding a quarter of a mile. The situation of Freetown, however, may be more generally stated to be at the foot, on the northern side of the range of mountains, which, coming from the interior, finds here its termination in the sea, and gives the name to the cape, harbour, and colony of Sierra Leone; the general height of the range, so far as it has yet been explored, is from 2,000 to 3,000 feet. The principal geological feature in the neighbourhood of Sierra Leone is a red granite, of easy and rapid decomposition."—*Captain (now General) Sir Edw. Sabine's Notes.*

COAST OF GUINEA, between CAPE THREE POINTS and CAPE LOPEZ, including the ISLANDS. Although we described this portion of coast in the "Directory for the Ethiopic or Southern Atlantic Ocean," we have considered it proper to continue the series of points in the table; and for a description of the coast, and remarks upon the positions, we refer the reader to the above work.

7. RIVER QUORRA.—This important river is described in the Directory mentioned in the preceding note. In the beautiful chart of it, by Captain William Allen, published in 1857, the East point of the entrance, formerly given by mistake in 6° 4′ E., is laid down in lat. 4° 20′ N., and long. 5° 55′ E. The bar, with 2 to 4 fathoms over it, extends 2 leagues southward from the mouth of the river, which demonstrates the strength of the ebb tide. Within the bar is an extent of 4 miles, the depths are 6 and 7 fathoms, but diminishing thence upward.

9.—THE AZORES, OR WESTERN ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
FORMIGAS or ANTS—	° ′ ″	° ′ ″	° ′	
Formigao or Hormigon, highest Rock	37 16 44	24 47 6	24 35	The Survey made by Captain A. T. E. Vidal, 1842.
Dollabarats Shoal, 11 ft.	37 14 30	24 43 25		
SANTA MARIA or ST. MARY—				
Ponto do Castello, or S.E. Point	36 55 30	25 1 30		
Villa do Porto	36 56 30	25 9 45		
Maldebarca Rock, off the N.W. Point [1]	36 59 31	25 12 3		
Pta. dos Matos	37 0 50	24 4 50		
SAN MIGUEL or ST. MICHAEL'S—				
Ferraria or West Point	57 51 40	25 52 0	24 55	
City of Ponta Delgada, Castle	37 44 0	25 41 15		
Villa Franca, Island	37 27 0	25 42 0		
Pta. Retorta. S.W. Point	37 44 25	25 10 45		
Punta de la Marquesa, or East Point	37 48 15	25 8 25		
Pta. da Ajuda	37 51 50	25 19 30		

THE AZORES, OR WESTERN ISLANDS—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Morro da Ribeira Grande	37 50 32	25 29 40		The Survey by Capt. A. T. E. Vidal, in 1842-44.
Porto Capellas, Morro ..	37 50 30	25 41 45		
Pta. de Bretanha	37 54 40	25 47 35		
TERCEIRA—				
Monte del Brasil, near Angra	38 38 33	27 14 10	25 35	
Praya, Pta. de Malmarenda	38 44 10	27 3 0		
Pta. de Serrata or W. Pt.	38 46 0	27 23 50		
ST. GEORGE—				
Pta. del Topo, or Island off S.E. Point.....	38 33 6	27 46 27		
Pta. de Rosales, or N.W. Point	38 45 5	28 20 15		
GRACIOSA—				
Fort at Praya.....	38 3 5	27 58 46	25 45	
Pta. de Fozo do Porto, or W. point.....	39 4 10	28 4 43		
PICO—				
The summit of the peak	38 25 0	28 28 12		
Pta. da Ilha, or E. point	38 25 0	28 2 45	25 50	
Magdalena Rocks, off W. point	38 32 5	28 34 0		
FAYAL—				
The S.E. point, or Morro de N.S. de la Guia....	38 31 20	28 38 5	25 55	
Caldeira, summit, 3,351 ft.	38 34 30	28 44 0		
Pta. da Negra, W. point	38 36 0	28 50 40		
FLORES—				
Sta. Cruz, Fort.....[2]	39 27 3	31 8 37		
CORVO—				
The Southern point, or Pta. del Pesqueiro-alto	39 40 7	31 8 0	26 40	

NOTES.

1. AZORES.—M. Fleurieu ascertained the position of the Mount of Brasil, near Angra, in Terceira, to be 38° 38′ 37″ N., and 27° 12′ 27″ W. Tofiño's result was 38° 38′ 10″ and 27° 14′ 40″ a remarkable coincidence, considering the distance of time at which the observations were made. The longitude of this spot was, therefore, assumed by the Spanish commander, as the meridian referred to from the points subsequently determined. The summit of the Mount, as given by Captain FitzRoy, R.N., is in 38° 38′ 35″, and 27° 12′ 54″.

Captain Alexander T. E. Vidal, R.N., who re-surveyed these islands, makes the Fort at Villa do Porto, in St. Mary's in lat. 36° 56′ 30″, long. 25° 9′ 45″ W.

2. FLORES AND CORVO.—The longitudes of these islands were given according to the results of Tofiño; they differ from those of Captain Vidal as now stated.

The VARIATION OF THE COMPASS is *decreasing* at the rate of about 4′ per annum.

10.—THE MADEIRA AND CANARY ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
MADEIRA.	° ′ ″	° ′ ″	° ′	
Town of Funchal, British Consul's Garden ....[1]	32 38 22	16 54 45	21 0	Capt. Matt. Flinders, H.M.S. *Investigator*, 1801; Gen. Sir Thomas Brisbane, 1821.
Camera de Lobos	32 38 35	16 59 0		
Punta del Parga, the West Point	32 48 7	17 16 20		
Tristao, or N.W. Point.. .	32 51 25	17 12 7		
S. Jorge Point	32 49 40	16 54 40		
Cape Garajao, or Brazen Head, S.E. extremity ..	32 37 18	16 51 42		Capt. W. Fitzwilliam Owen, 1820, 1827.
Pta. de S. Lourenzo, the Lighthouse.....	32 43 10	16 39 30		
Pico Ruivo, summit, 6,056 feet	32 45 0	16 57 0		
PORTO SANTO—				
Villa Baleira on the South side	33 3 30	16 20 3	20 40	Capt. A. T. E. Vidal, 1844.
Baixo Island, South point	52 59 10	16 18 50		
DEZERTAS—				
Chao Island, Sail Rock..	32 35 45	16 33 0		
Bujio Island, Agulha Pt.	32 24 0	16 28 20		
The SALVAGES—				
Middle of the Great Salvage.....	30 8 30	15 55 36		
CANARY ISLANDS.				
LANZAROTE, or LANÇEROTE				
Allegranza Isle, off the North end	29 25 30	13 30 30	19 20	
Port de Naos, Lighthouse	28 57 20	13 33 0		
FUERTAVENTURA—				
Isle of Lobos, Point Martino, Lighthouse	28 45 25	13 48 0		
Point Jandia, the S.W. Point	28 3 0	14 31 30		
CANARIA, or GRAND CANARY—				
The Isleta, or N.E. Point	28 11 0	15 25 10	19 35	
Point Arguineguin, or S. Point	27 44 55	15 40 10		
Point Aldea, the W. Pt.	28 1 0	16 0 30		
TENERIFE, or TENERIFFE—				
Santa Cruz, Mole Lt. [3]	28 28 33	16 14 56		
Pico de Teide, summit ..	28 16 35	16 38 2		
Orotava, N.W. side	28 25 0	16 33 0	19 50	
Pta. de Anaga, E. Point	28 33 50	16 6 0		
Pta. de la Rasca, S. Pt.	28 0 30	16 41 0		

MADEIRA AND THE CANARY ISLANDS—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
GOMERA—	″ ′ °	″ ′ °	° ′	
The Port	28 8 0	17 5 55		
Pta. de Calera, W. Point	28 6 45	17 22 0		
PALMA—				
Sta. Cruz, on the E. side	28 40 30	17 44 28		
Taxacorte, on the W. side	28 38 12	17 55 55		
FERRO—				
Port de Hierro	27 46 30	17 54 22	20 20	
Point Orchilla, S.W. Pt.	27 42 20	18 9 45		
Pta. de la Restinga, S. Pt.	27 37 3	17 59 50		

NOTE.

1. FUNCHAL.—The latitude of Funchal is well ascertained. The longitude was estimated by M. Bory, in 1772, as 16° 56′. It is unnecessary to repeat the varying results of other observers, the differences having been decided by our respected countryman, Captain Flinders, from whose observations, in H.M.S. *Investigator*, 1801, the latitude of the road appeared to be 32° 37′ 44″, and the greatest longitude, by any of six chronometers, 16° 54′ 26″.

Sir Thomas Brisbane, on his voyage to New South Wales (1821), obtained his time at the house of Mr. J. W. Gordon, at Funchal, by four excellent chronometers, by which the mean longitude was concluded as 16° 54′ 36″. At the same time the latitude of the tower, on Mr. Gordon's house, was found to be 32° 38′ 19.7″, and that of the Loo Rock, 32° 37′ 53.8″. The longitude given by Sir Thomas Brisbane was confirmed by ten Admiralty chronometers, under the care of Dr. Tiarks, in 1823, which gave for the longitude of the British Consul's Garden, 16° 54′ 45″ (in time, 1^{h} 7^{m} 39^{s}), the position given in the Table.

Captain Fitzwilliam Owen, from observations in H.M.S. *Leven*, in 1820, gives the landing-place, near the Loo Castle, in 32° 37′ 42″ N., and 16° 55′ 30′ W.

Captain Wm. Mudge, R.N., who, with Captain Vidal, surveyed the Great Salvage in 1820, places its South side in 30° 7′ 39″ N., and 15° 56′ 18″ W.; and he says of it—"This island is obviously of volcanic origin, and consists principally of a dark-coloured black rock, the detached parts of which, as well as the whole, exhibit strong marks of fixed magnetic polarity. Even the dust of the roads, and of the floors of the cottages, has the same character as the rock itself, and may be gathered up, like steel filings, by means of a bar magnet."

2. TENERIFE.—The position of Sta. Cruz in the Table is that given by Captain Vidal in his completion of the survey of these islands (1844). The previous observations have placed the longitude generally one or two minutes more, or to the westward of those in the Table.

Capt. Fitzwilliam Owen, from his observations in the *Leven*, 1820, gives the Mole Head in 28° 27′ 54″ N., and 16° 15′ 0″ W. The peak he gives in 28° 16′ 24″ N., and 16° 39′ W.

The VARIATION of the COMPASS is *decreasing* at the rate of 4′ or 5′ per annum.

11.—CAPE VERDE ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
SAL or SALT ISLAND:—				The Survey of the Cape Verde Islands, by Lieutenants (afterwards Captains) Vidal and Mudge, R.N.; taken by order of the Lords Commissioners of the Admiralty, in the years 1819, 1820, and 1821, compared with the observations of Captains King, Foster, Owen, &c.
The North Point	16 51 0	22 54 34		
The South Point	16 34 0	22 56 4		
BONAVISTA:—				
The N.W. Point	16 13 20	22 55 41		
The N.E. Point	16 11 0	22 42 31	29 25	
The New Town	16 7 0	22 55 34		
The South Point	15 57 0	23 44 0		
Leton Rock	15 48 0	23 9 4		
MAYO, or ISLE OF MAY:—				
The North Point	15 12 30	23 12 4		
English Road	15 7 30	13 13 4		
South Point	15 6 40	23 10 4		
ISLAND OF ST. IAGO:—				
Bighude, or North Point	15 19 30	23 45 34		
East Point	15 0 30	23 25 56		
Porto Praya, Quail I. [1]	14 53 40	23 30 34		
S.W. Point	14 58 30	23 44 56		
ISLAND OF FOGO:—				
North Point	15 1 15	24 22 0		
Town of N.S. da Luz	14 53 0	24 31 0		
BRAVA:—				
Road on the West side	14 48 0	24 43 34		
ST. NICHOLAS:—				
East Point	16 34 30	24 0 0	20 5	
North Point	16 42 0	24 21 20		
West Point	16 38 0	24 27 0		
South Point	16 28 30	24 19 0		
RAZA, East Point	16 38 0	24 38 30		
ST. LUCIA:—				
East Point	16 46 0	24 42 0		
North Point	16 49 0	24 47 30		
ST. VINCENT:—				
Porto Grande	16 54 42	25 1 12		
ST. ANTONIO:— [2]				
North Point	17 12 0	25 6 45	20 0	
West Point	17 4 0	25 23 10		
South Point	16 55 0	25 19 25		
East Point	17 5 30	25 0 5		

NOTES.

1. PORTO PRAYA.—The longitude of this place appears to be well determined; particular attention having been directed to it by many of our most skilful navigators. Captain FitzRoy places the West point or landing-place on Quail Island (called also Gun Point), at Porto Praya, in longitude 23° 30′ 0″ W. Captain P. P. King had made it 23° 30′ 17″;

Captain Vidal, 23° 31′ 28″; and Captain Owen, 23° 31′ 3″; therefore, 23° 30′ 34″, the longitude formerly assigned to it by Mr. Purdy, in previous editions of this work, cannot be far from the truth.

2. Capt. King made Terrafal Bay, at the S.W. end, by eleven chronometers, in longitude 25° 20′ 1″; Captain Owen made it 25° 21′ 42″; and Captain Foster, 25° 22′ 56″; therefore, from these it will be about 25° 21′ 30″; and the West point, 25° 23′ 10″.

The VARIATIONS of the COMPASS are now *increasing* at the rate of 5′ per annum.

12.—THE FÆROE ISLES, ICELAND, GREENLAND, LABRADOR, AND NEWFOUNDLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
THE FÆROE ISLANDS.	° ′ ″	° ′ ″	° ′	
Munkön Islet	61 23 40	6 37 30	26 25	The Survey by CAPT. BORN, of the Danish Navy, 1790-5, published in 1806, subsequently corrected.
Suderö, Porkerji	61 31 32	6 42 0		
Landö, Village	61 52 30	6 46 0		
Waagö, Sorwaag	62 5 0	7 12 30		
Myggenæs, West Point	62 6 0	7 36 0		
Stromö, Thorshavn	62 2 40	6 43 0	26 50	
Osterö, Ristang N. Point	62 22 0	6 56 0		
Fuglö, East Point	62 18 40	6 10 0		
ICELAND.				
Snefells Jokel, 4700 feet	64 48 0	23 50 0	45 45	
Breidavik, Stapi	64 46 15	23 40 0		
Akra Nes	64 39 40	22 30 0		
Thormod's Skar, S. point	64 25 30	22 22 0		
REIKIAVIK	64 8 20	21 59 15	44 0	Mr. BJORN GUNNLAUGSSON'S Survey, 1849, and French Survey, 1859.
C. Utskalar Beacon	64 4 50	22 45 45		
Reykjanes Point	63 48 0	22 45 50		
Grindavik Church	63 49 0	22 35 0		
Herdisarvik, anchorage	63 51 20	21 51 15		These longitudes are 6′ or 8′ further West than those of the Danish Survey, 1845.
Keflavik, anchorage	61 50 30	21 31 30		
Olfusa, entrance	63 52 0	21 15 45		
Piorsa, entrance	63 46 40	20 53 15		
Affall, entrance	63 37 45	20 35 30		
Markarfliot, entrance	63 31 30	20 5 0		
Hohla, 5364 feet	63 59 0	19 45 0		
Portland Head, S. point of Iceland	63 23 45	19 12 0	43 0	
Ingolfs Höfde	63 48 50	16 35 0		The DANISH Survey, 1845, &c.
Horne Fiord, entrance	64 15 0	15 8 30		
Hvalsbak Islet	64 37 0	13 21 0		
Rode Fiord, Krosnæs	65 1 30	13 32 50		
Hornnæs, East point of Iceland	65 10 50	13 28 0	36 30	
Langanæs, N.E. point	66 23 0	14 28 0		
Tiornæs	66 13 40	17 7 0		
Grimsey Church	66 33 30	18 0 0		
Holar Church	65 45 30	19 5 0		
Skagen, Skagataa	66 8 0	20 3 30		
North Cape	66 29 0	22 25 0	15 0	
Staalbierg Huk, W. Point	65 30 25	24 30 15		

GREENLAND, LABRADOR, &c.—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878 9.	AUTHORITIES.
GREENLAND.	° ′ ″	° ′ ″	° ′	
Land reported, 1670 .. [1]	78 33 0	19 0 0	43 0	North German Polar Expedition, 1870.
Cape Bismarck	76 47 30	18 30 0		
Pendulum Island, 3,000 feet	74 39 0	18 31 30		
Cape Hold-with-hope, 3,000 feet	73 26 0	20 0 28	46 0	
K. Francis Joseph Fiord, entrance	73 12 0	22 25 0		
Davy Sound, Smith Island	71 49 0	22 20 0		
Cape Gladstone	71 30 0	21 38 0		
Scoresby Sound, Cape Brewster.....	71 0 0	21 55 0	47 0	
Knighton Inlet, C. Barclay	69 10 0	24 30 0		
Horror Bay	66 49 0	33 20 0	53 0	
Cape Dan .....[2]	65 37 0	36 10 0		The CHART of GREENLAND, published by authority at Copenhagen in 1832. to illustrate the voyage of Capt. Graah.
Dannebrogs Oe or Isle	65 18 0	38 30 0		
Cape Löwenorn	64 30 0	39 30 0		
Colberger Heide	64 8 0	40 7 0		
Cape Mosting.....	63 40 0	40 15 0		
Cape Juel	63 15 0	40 50 0		
Kinarbie	62 47 0	41 42 0		
Cape Bille	61 58 0	42 5 0		
Cape Tordenskiold.....	61 24 0	42 20 0		
Cape Discord.....	60 53 0	42 30 0		
Cape Valloe	60 38 0	42 45 0		
CAPE FAREWELL or Statenhuk	59 49 12	43 53 40	52 30	
Frederiksdalor Ikigeit	60 0 0	45 6 0		DANISH CHART, with additions from U.S. Exp. under Kane and Hayes, 1854—1861, and Hall, 1871-2.
Arsuk Fiord, Ivugtut	61 12 0	48 21 0	55 0	
Frederikshaab	62 0 0	49 42 0		
Godthaab Fiord, entrance..	64 5 0	52 20 0		
Holsteinborg	66 56 0	53 40 0		
Disko Bay, Egedesminde..	68 42 0	53 5 0		
„ Christianshaab	68 48 0	51 16 0	68 0	
„ Jakobshawn ..	69 12 30	51 14 0		
„ Godhavn.....	69 14 0	53 40 0		
Disko Island, E. side, coal cliffs.....	70 0 0	53 10 0		
Hare Island (coal) N. point	70 28 0	55 0 0		
Upernivik	72 48 0	56 20 0		
Carey Islands, southern ..	76 40 0	72 20 0		
Hall's Rest, Tablet erected by British, 1876..... ..	81 38 0	61 40 0	100 0	
Alert, Winter Q., 1875-6 ..	82 27 0	61 20 0		*Alert* and *Discovery*, 1875-6.
Markham & Parr's farthest	83 20 26	63 0 0		
Cape Colombia (Aldrich)..	83 7 45	70 30 0		
Aldrich's farthest	82 21 0	56 0 0		
Beaumont's farthest	82 20 0	51 0 0		
LABRADOR [3].				
Resolution Island, C. Best	61 21 0	64 55 0	55 0	Various authors up to 1876.
Cape Chidley	60 30 30	64 55 0		
Eclipse Har., Mt. Bache, 2,150 ft.	59 51 17	64 5 15		
Ramah Mission Station ..	51 49 0	63 30 0		

LABRADOR—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Hebron Mission Station, anchorage	58 5 30	62 51 30		
Akkak Mission Station	57 38 0	62 18 0		
Port Manvers, entrance	57 0 0	62 7 0		
Nain Church	56 32 45	61 40 30		Staff Commanders Maxwell, 1873-5, and Chimmo, 1867.
Ford Harbour Head	56 26 59	61 13 11		
Farmyard Isles	55 49 30	58 52 0		
Hopedale Mission Station	55 27 4	60 11 49		
Gull Island, North end	55 30 20	59 43 0		
Cape Mokkovik	55 13 50	59 8 20	43 0	
Aillik Bay, H. B. Co. Sta.	55 9 0	59 5 0		
Webeck Har., (Cannatocktuit), Harbour Rocks	54 54 27	58 1 51		
Cape Harrison	54 55 50	57 55 40		
Bulldog Island	54 45 10	56 50 0		
Hamilton Inlet, Rigoulette	54 11 20	58 25 10		
„ Herring Isles, S.E. extreme	54 19 24	57 5 0		
Outer Gannet Island	54 0 0	56 32 0		
Independent Island, S. pt.	53 50 40	56 51 30		
The Wolves, S.E. one	53 48 16	56 19 0		
Curlew Har., Curlew Id.	53 46 0	56 33 18		
Cartwright Harbour	53 42 37	56 59 50		
S. Wolf Island, S. Wolf Rock	53 38 55	55 53 0		
Domino Run, Spotted Id., S.E. point	53 29 30	55 43 10		
„ Grog Island, summit	53 30 36	55 52 30		
Roundhill Island, S.E. end	53 25 45	55 36 0		
Shoal Bay, E. entrance pt.	53 17 0	55 46 0		
American Tickle, Long Id.	53 12 50	55 41 29		
Partridge Island, E. end	53 10 30	56 12 25		
Boulter Rock	53 6 15	54 45 38		
Venison Tickle Flagstaff	52 58 9	55 45 55		
Cape Bluff	52 50 15	55 48 0		
St. Michael Bay, First pt.	52 42 0	55 48 18		
Occasional Har., Twin Ids.	52 40 0	55 44 18	39 10	
Fishing Ship Harbour, Entrance Island	52 36 10	55 45 20		
Cape St. Francis	52 33 30	55 41 30		
St. Lewis Sound, Goose Id.	52 19 17	55 42 50		
Islet Bay, anchorage	52 13 0	55 42 0		The Surveys by Admiral Bayfield, 1827—1860.
Peterel Island, S.E. end	52 4 0	55 41 0		
Chateau Bay, York Point	51 58 0	55 52 40		
Barge Bay	51 48 0	56 11 0		
Amour Point Lighthouse	51 27 10	56 51 30		
NEWFOUNDLAND [4].				
Belle Isle, N.E. point	52 1 8	55 15 30		The Survey by Captain F. Bullock, R.N.
„ Lighthouse on South point	51 53 0	55 22 15		
CAPE NORMAN Lighthouse	51 38 0	55 53 40		The Admiralty Surveys by
Cape Bauld	51 39 0	55 25 0	37 0	Lieut. (since Adm.) Frederick
Griguet Bay, East point	51 32 33	55 26 20		Bullock, R.N., and his assist-

NEWFOUNDLAND—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
White Cape, near St. Lunaire Bay	51 30 25	55 26 20		ants, Messrs. T. Smith, &c.,
Bréhat or Braha Shoal	51 25 40	55 26 20		1823, 1824, 1825, and 1826.
Cape St. Anthony	51 21 44	55 31 0		The longitudes adjusted by the
Crémaillière Cove, entrance	51 20 0	55 35 0		observations of Capt. H. W.
Goose Cape, S.E. point	51 18 20	55 35 0		Bayfield, &c.
How Harbour, entrance, W. point	51 20 45	55 56 0		
Fishot Isles, Northern Isle	51 12 30	55 39 20		REMARKS.
Croc Harbour, entrance	51 3 0	55 44 0		
Groais Isle, N.E. point	50 58 30	55 30 30	35 25	By these excellent Surveys, a
Bell Island, N.E. Rock	50 48 30	55 25 50		very important desideratum was
Rouge Isle, N. point	50 54 30	55 43 45		obtained; for before they were
Canada Bay, entrance	50 42 30	56 6 20		executed, the coasts which they
Hooping Harbour, entrance	50 36 30	56 12 40		display were comparatively un-
Fourchette Har., entrance	50 31 45	56 16 20		explored, although frequented
Orange Bay, entrance	50 22 0	56 25 45		more or less by the fishers.
Little Harbour, Deep Head	50 14 0	56 31 45		
Cat Head, extremity	50 12 10	56 38 50		
Coney Head Arm	49 57 50	55 46 0		
Partridge Point	50 9 20	56 9 20		
Fleur de Lys Harbour, Bear Hill	50 6 35	56 7 42		
St. Barbe, or Horse Isles, S.E. point	50 11 10	55 41 50	34 15	
Paquet Harbour, entrance	49 58 30	55 51 38		
La Scie Harbour, entrance	45 58 0	55 36 50		
CAPE ST. JOHN.				
North Bill	49 59 30	55 30 10		
South Bill	49 56 25	55 28 30		
St. John's Gull Isle	49 59 30	55 21 30		The Admiralty Surveyors,
Bishop's Rock	49 55 30	55 26 40	33 40	Messrs. George Holbrook and
Nippers' Isles, S.E. Point	49 47 0	55 51 0		William Bullock, 1819 to
Cutwell Harbour, E. Point	49 37 0	55 40 0		1826.
Triton Harbour, entrance	49 33 0	55 37 0		
Fortune Harbour, N.W. Point	49 32 0	55 17 0		
Toulinguet Island Light-ho.	49 41 0	54 49 0		
Change Isles, N.E. Islet	49 41 35	54 24 0		
Fogo Isles, Change Island, Tickles, Tobacco Island	49 41 35	54 23 35		The Admiralty Survey under Staff Commander J. H.
„ Fogo Har., Slade's staff	49 43 0	54 16 19		Kerr, R.N., 1866 — 1871,
„ Hare Bay, N. entr. point	49 40 24	54 17 13		and Captain Orlebar, R.N.,
„ Seldom-come-by Harbour, Ship Hill	49 36 50	54 11 57		1862—4.
Ireland Rocks, East end	49 51 30	54 1 30		
Snap Rock	49 53 15	53 42 30		
Funk Island, West end	49 45 25	53 11 10		
Offer Wadham Id. Light	49 35 45	53 45 30		
Gander Island, N. point	49 28 10	54 22 25		
Deadman Point	49 21 30	53 40 10		
Cape Freels, Brandies Id.	49 16 40	53 27 40	33 20	
Puffin Island Light	49 3 40	53 32 38		
Offer Gooseberry Island, N. end	48 56 35	53 31 40		

NEWFOUNDLAND—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Salvage Bay, Cow Head ..	48 42 0	53 38 40		The Admiralty Survey under Staff Commander J. H. Kerr, R.N., 1866—1871, and Captain Orlebar, R.N., 1862—4.
Barrow Har., Gerrard Hill	48 40 48	53 39 14		
CAPE BONAVISTA Light ..	48 41 58	53 4 35	32 20	
Kelp Rock, breaks	48 47 50	53 3 30		
Catalina Harbour, Green Island Lighthouse.....	48 30 15	53 2 40		
Horse Chops	48 20 46	53 12 25		
Trinity Har., Fort Point Lighthouse.....	48 22 0	53 20 50		
Bonaventure Head	48 16 50	53 23 25		
Trinity Bay, E. Random Head	48 5 45	53 33 0		
„ Deer Har. Green I.	47 53 43	53 42 25		
„ Tickle Point.....	47 42 10	53 40 20		
„ Heart's Content, Church	47 52 35	53 22 14		
„ New Perlican Ch.	47 54 45	53 21 40		
„ Salvage Point	48 3 55	53 9 0		
„ Grates Point	48 10 15	52 56 40		
Baccalieu Island Light....	48 8 45	52 47 50		
Conception Bay Harbour, Grace Id. Lighthouse ..	47 42 45	53 8 14		
„ Bay Roberts, East entrance point	47 36 45	53 10 0		
„ CAPE ST. FRANCIS Light	47 48 30	52 47 10	31 40	
Black Head	47 45 40	52 42 40		
Torbay Point.....	47 39 40	52 39 40		
ST. JOHN'S HARBOUR, Chain Rock Battery [7]	47 34 2	52 40 50		
„ Fort Amherst Light, S. side of entrance	47 33 50	52 40 20		
Cape Spear Light	47 31 20	52 37 12		
Bull Head	47 18 25	52 44 45		
Cape Broyle, North Point	47 4 20	52 50 50		Captain James Cook, Captain (Rear-Admiral) H. W. Bayfield, 1827 to 1860), Captain Orlebar, 1862, and Staff Commander Maxwell, 1873—1876.
Cape Ballard	46 47 10	52 56 45		
CAPE RACE, Lighthouse ..	46 39 25	53 4 20	29 20	
Virgin Rocks, on the Gt. Bank of Newfoundland	46 26 30	50 57 30		
Trepassey Harbour, Shingle Neck	46 43 32	53 22 13		
Cape Pine, Lighthouse....	46 37 4	53 31 45		
St. Mary's Cape, Lightho.	46 49 30	54 11 30		
Placentia Harbour, Privecœur Point.....	47 15 24	53 59 30	29 45	
Cooper Cove, Obs. spot....	47 17 55	53 58 35		
Fox Island, S.W. Point ..	47 21 10	53 59 5		
Burin Island Light	47 0 26	55 8 43		
Corbin Head	46 56 20	55 14 0		
Great St. Lawrence Harbour, Episcopal Church	46 55 26	55 22 58		
St. Pierre Island, Galantry Head Lighthouse	46 45 30	56 9 32		
„ Pigeon Island, N. pt.	46 47 25	56 7 52		
Green Island, West point..	46 52 10	56 5 38		
Miquelon Ids., Cape Coupé, South point	46 46 39	56 21 0		

NEWFOUNDLAND—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Miquelon Road anchorage	47 6 0	56 33 0		Captain James Cook, Captain (Rear-Admiral H. W. Bayfield, 1827 to 1860), Captain Orlebar, 1862, and Staff Commander Maxwell, 1873—1876.
„ Cape Miquelon, N. pt.	47 8 12	56 20 35		
Brunet Island Lighthouse	47 15 30	55 51 50		
Devil Bay, E. entrance pt.	47 36 40	56 37 10		
New Harbour, entrance	47 35 30	56 39 10	28 45	
Fransway or Francois Bay, W. entrance point	47 33 30	56 44 0		
Cape La Hune	47 31 30	56 51 50		
Little River Point	47 34 5	57 7 15		
Old Man's Bay, E. point	47 35 35	57 10 50		
Ramea Ids., Ramea Har., N. entrance point	47 30 30	57 24 30		
Bear Island, W. point	47 36 35	57 23 35		
Burgeo Ids., Boar Island Lighthouse	47 36 10	57 35 10		
La Poile Bay, Great Har., Episcopal Church	47 39 48	58 24 18		
Rose Blanche Point Lt.-ho.	47 35 50	58 41 30		
Port Basque, Channel Ch.	47 33 56	59 7 33		
CAPE RAY Lighthouse [8]	47 37 0	59 18 0	28 0	
Codroy Roads, Beach Point	47 52 38	59 23 47		
St. George Har., Sandy Pt.	48 27 27	58 30 31		
Cape St. George	48 28 25	59 15 50		
Bay of Islands, South Head	49 5 25	58 20 20		
Cape Gregory	49 22 20	58 13 0		
Bonne Bay, South entr. pt.	49 32 30	57 58 30		
Cow Head	49 55 0	57 50 20		
Pich Point Lighthouse	50 41 55	57 24 0		
St. John Har., S. entr. pt.	50 48 10	57 14 50		
Ferolle Point, S.W. extr.	51 1 0	57 5 0		
Green Island	51 24 0	56 34 0		
CAPE NORMAN Lighthouse	51 38 0	55 53 40	37 0	

NOTES.

1. The North German Polar Expedition of 1870, consisted of the steam-ships *Germania*, 143 tons, and the *Hansa*, a sailing vessel of 242 tons. Its object was geographical discovery towards the North Pole by the eastern coast of Greenland. On reaching the coast, the vessels became separated, the sailing ship, proceeding to the southward, was ultimately lost in a storm, and the crew taking refuge on an ice-floe were drifted several hundred miles to the southward, to within reach of a Danish settlement near the southern extremity of Greenland. The *Germania* wintered near the southern end of Pendulum Island, near the locality of Sir Edward Sabine's magnetic observatory, when he visited the locality with Captain Clavering in 1823. From this point sledging expeditions in the spring of 1870 were undertaken, which reached as far as 77° north latitude. In returning down the coast a fiord, penetrating far into the interior of East Greenland, was discovered and partly explored. It is situated between Capes Franklin and Humboldt, and was found to be surrounded by a highly picturesque mountainous country, with sheltered and verdant pastures near the water, inhabited by herds of musk-oxen and reindeer.

2. An interesting account was published of the *Discoveries of the Eastern Coast of Greenland*, by Capt. Graah, of the Danish Royal Navy, in 1829, who proceeded along the

coast from Staten Hook, to the parallel of 65½°, and who has disproved the existence of any ancient European colony upon it. In a single boat, amid difficulties almost insuperable, with only two Greenland men and four women, M. Graah reached an island, in latitude 65° 18′; longitude, *computed*, 38° 27′; he proceeded onward until stopped by an insurmountable barrier of ice, and was forced to return to the S.W.

All the coast appeared to be colder, more barren, and miserable, than the western coast. "It may be said to consist of one uninterrupted glacier, exhibiting only a few patches of vegetation, generally on the banks of the rivers, and elsewhere, often advancing into the sea, and forming promontories of ice, which are passed with so much the more danger that they frequently fall in avalanches." During the whole summer of 1829 there was not one day which could be called warm; and, before the 14th of June, the thermometer had never risen above 53°.

During his last stay, in 1831, Capt. Graah determined the longitudes of the two southern Danish settlements, *Julianeshaab* and *Nennortalic*, with great precision, by means of occultations of fixed stars, &c.; and we also gain, by his observations, the positions of *Cape Farewell*, never before ascertained, and *Cape Christian*, another promontory of the same island; Cape Farewell, lat. 59° 49′ 12″, long. 43° 53′ 40″; Cape Christian, lat. 59° 42′ 30″, long. 44° 45′ 0″.

The eastern coast is distinguished by the name of the late excellent *King Frederick VI.*

3. LABRADOR.—The eastern coast of Labrador has been surveyed by the Newfoundland survey party under Commanders Chimmo and Maxwell. It has been an arduous undertaking, on account of the shortness of the navigable season. The survey had in 1876 been fairly completed to Halton Harbour, the northernmost fixed settlement of the Newfoundland fishermen. From that port northward to Nain, a Moravian Missionary settlement, a distance of nearly 200 miles, the coast had been explored, and the principal headlands fixed by astronomical observation.

4. NEWFOUNDLAND.—The work of the surveyors in recent years has placed the coast of the island in a much more satisfactory light to the navigator. Previously great errors existed. The assigned positions of Cape Bonavista is an evidence of the uncertainty which existed in the longitudes of the old surveys. The first sheet of the survey by Messrs. Holbrook and Bullock, in 1817, made the long. 52° 59′ 15″. In the re-issue, shortly afterwards, of the same sheet, it was shifted to long. 53° 8′ 20″, or 8° 35′ further West. In the modern survey it is placed in 53° 4′ 35″.

The coasts to the northward appear to have been given much more to the *westward*. It is necessary to notice these discrepancies here, although the amounts of differences, as now settled, are not important to the general navigator.

The exact longitude was determined by the Electric Telegraph connecting Ireland with Hearts Content in Trinity Bay in 1867, and from this the principal meridian has been deduced. The Admiralty Survey takes the Chain Rock Battery, on the North side of the entrance of St. John's Harbour as the meridian.

The West coast of Newfoundland is still represented according to the surveys of the circumnavigator, Captain James Cook and Michael Lane at the latter part of the last century. The original charts of the West and South coasts were published by Mr. Laurie's predecessors, and it will be seen, upon comparison, that the positions given in Cook's first work are still found to be near the truth.

The VARIATIONS OF THE COMPASS are nearly stationary in Newfoundland and Labrador.

13.—GULF AND RIVER OF ST. LAWRENCE, WITH CAPE BRETON ISLAND.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
THE GULF. [1]				
ISLAND OF ST. PAUL. [2]	° ′ ″	° ′ ″	° ′	
Northern Extreme Lighthouse	47 13 50	60 8 20	27 15	The observations of Captain (afterwards Admiral) Henry Wolsey Bayfield, F.R.A.S., of H.M. surveying vessel, *Gulnare*, 1827 to 1834.
Eastern side of Neck	47 13 9	60 8 30		
South Point Lighthouse	47 11 20	60 9 40		
MAGDALEN ISLANDS. [3]				
Entry Isle, Lighthouse on S.E. side	47 16 30	61 41 0		
South Cape Lighthouse	47 13 0	61 58 0		
Deadman Islet, W. Point	47 16 3	62 12 28		
Grindstone Island Light	47 23 10	61 56 30		
Coffin's Island, N.E. Point	47 37 30	61 23 0		
Bird Islet Lighthouse	47 50 40	61 8 20	26 40	
Byron or Cross Isle, E. Pt.	47 47 53	61 23 40		
ANTICOSTI. [4]				
East End, Heath Point Lighthouse	49 5 20	61 42 30		
South Point Lighthouse	49 4 0	62 16 0		
S.W. Point Lighthouse	49 23 45	63 35 49		
Cape Henry, S.E. extreme	49 47 42	64 23 44		
West Point, Lighthouse	49 52 30	64 31 40	27 40	
North Point, extremity	49 57 32	64 9 0		
Observation Cape, W. side	49 38 51	62 41 27		
Bear Bay, entrance of the River	49 30 22	62 24 32		
LABRADOR, &c. [5]				
Bradore Harbour, Flagstaff on Jones House	51 27 30	57 14 15	36 30	The Surveys by Admiral H. W. Bayfield, 1827—1860.
Belles Amours Point, S.E. extreme	51 26 34	57 25 53		
Lion Island, Isthmus	51 24 1	57 38 33		
Mistanoque I., E. Point of Cove in N. side Island	51 15 43	51 12 8		
Mecattina Harbour, South Point of Dead Cove	50 46 44	58 59 23		
Grand Mecattina Point, ex.	50 44 2	59 5 13		
Antrobus Point, North Point of Island	50 33 12	59 16 48		
Hare Harbour, East side	50 36 24	59 17 23		
Wapitagun Harbour, East Point of Islet	50 11 40	60 1 23		
Cape Whittle, S.W. extreme of Lake	50 10 36	60 7 0	32 0	

GULF AND RIVER OF ST. LAWRENCE—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Coacoacho Bay, S. Point of Outer Islet	50 9 4	60 18 13		The Surveys by Admiral H. W. Bayfield, 1827-60.
Kegashka Bay, Islet at S. end of Beach	50 11 19	61 15 38		
Natashquan River, S. Point of entrance	50 6 57	61 47 58		
Little Natashquan Harbour, North Point Islet at head of Bay	50 11 41	61 50 33		
Nabesippi River, S.E. of entrance	50 13 52	62 13 0		
Appetetat Bay, East Point	50 16 35	62 58 13		
Betchewun Harbour, S.E. Point of Low Isle	50 14 13	63 10 32		
Clearwater Point, South extreme	50 12 27	63 27 6		
Mingan Harbour, Sandy Point	50 17 24	64 1 56	28 50	
Mingan Island, summit	50 12 48	64 7 31		
St. John River, East Point of entrance	50 17 3	64 23 16		
Manitou Point, extreme	50 17 34	65 14 8		
St. Charles Point, South extreme	50 15 17	65 48 48		
Moisic River, S.W. point of entrance	50 11 16	66 4 38		
Carousel Island, Lighthouse	50 5 40	66 22 40		
Seven Islands Bay, Storehouse, East side	50 13 0	66 24 4	26 35	
St. Margaret's Bay, extreme	50 2 25	66 44 43		
Cawee Islands, West Point of Little Island	49 29 21	67 1 53		
Egg Island, Lighthouse	49 38 13	67 10 6		
Trinity Bay, S.W. Point	49 23 39	67 18 8		
Point de Monts, Lighthouse	49 19 35	67 21 58		
,, South extreme	49 18 41	67 23 18	24 40	
RIVER ST. LAWRENCE, N. SHORE.				
Goodbout R., Trading Post	49 18 25	67 37 4		
St. Nicholas Point, South extreme	49 15 47	67 50 4		
Manicougan Point, S.E. extreme	49 6 5	68 11 55		
Bersimis River, South Point of entrance	48 55 23	68 36 54		
,, Point, S. extreme	48 53 57	68 38 29		
Jeremie, Trading Post	48 52 45	68 46 46		
Port Neuf, Church	48 37 17	69 5 53		
Saguenay R., Lark Islet, Lighthouse	48 5 30	69 39 0	20 40	
Chicoutimi (Saguenay R.), Trading Post	48 26 5	71 4 51		
Isle aux Coudres, W. point of Laprairie Bay	47 24 40	70 24 52		

GULF AND RIVER OF ST. LAWRENCE—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
QUEBEC, N. Bastion [6]	46 49 0	71 12 49	17 25	The Surveys by Admiral H. W. Bayfield, 1827-60.
„ Wolf Monument	46 48 38	71 12 31		
„ Flagstaff, King's Bastion, Citadel.....	46 48 32	71 12 33		
RIVER ST. LAWRENCE; ABOVE QUEBEC.				
St. Jean des Chaillons, R. C. Steeple	46 33 23	72 7 6		
C. Madeline, R. C. Steeple	46 22 6	72 30 3		
Three Rivers, E. Steeple ..	46 20 43	72 32 10		
Point du Lac, R. C. Steeple	46 17 21	72 41 20		
Sorel, Episcopal Church ..	46 2 42	73 6 50		
Repentigny, R. C. Steeple	45 44 28	73 26 49		
MONTREAL, Gate Island, N. end Lighthouse	45 30 22	73 33 5	11 50	
„ R. C. Cathedral [7]	45 30 24	73 33 18		
RIVER ST. LAWRENCE; S. SHORE.				
Dauphin River, Orleans Isle, S.W. point of entr.	46 58 4	70 50 44		
Stone Pillar Id. Lighthouse	47 12 25	70 21 39	18 50	
Kamouraska, N.E. point of Crow Island	47 35 9	69 52 39		
Brandy Pots, South point of South Rock	47 52 28	69 40 39		
Loup River, North point of entrance	47 50 57	69 33 41		
Red Island, Lighthouse ..	48 4 20	69 32 59		
Green Island, Lighthouse..	48 3 17	69 25 6		
Razade Rocks, N.E. one ..	48 12 27	69 8 3		
Bicquette Island, Lightho.	48 25 18	68 53 20		
Bic Island, N.E. extreme of S.E. Reef	48 25 9	68 58 23		
Barnaby Island, N.E. pt...	48 29 35	68 31 56	22 30	
Father Point Lighthouse..	48 31 25	68 27 40		
Camille Mt., summit 2,036 feet	48 28 36	68 12 50		
Little Metis Lighthouse ..	48 41 10	68 2 15		
Matane River, Lighthouse	48 52 35	67 33 0		
Cape Chatte, Lighthouse ..	49 5 52	66 45 30		
Cape Magdalen Lightho.	49 15 40	65 19 30		
Martin River lighthouse	49 13 20	66 9 0		
Great Fox Bay, centre of..	48 59 57	64 22 55		
Cape Rozier, Lighthouse ..	48 51 37	64 12 3		
Cape Gaspé, Lighthouse ..	48 45 15	64 9 15	26 0	
NEW BRUNSWICK, &c.				
Cape Despair, Lighthouse	48 25 40	64 18 20		
Macquereau Pt., Lighthouse	48 12 30	64 46 10		
Port Daniel, North side, West point	48 9 10	64 56 55		

GULF AND RIVER OF ST. LAWRENCE—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Paspebiac, Episcopal Ch...	48 1 47	65 15 6		The Surveys by Admiral H. W. Bayfield, 1827-60.
Bonaventure Point, South extreme	48 0 17	65 26 26		
Carlton, or Tracadigash Pt., N.W. extreme	48 5 9	66 7 10		
Dalhousie I., East point ..	48 4 16	66 21 26		
Black Rock, Station on ..	47 51 54	65 45 30		
Bathurst Harbour, Alston Point, North Lighthouse	47 39 20	65 36 40		
Mizzenette Point, Station .	47 50 2	64 58 43		
Caraquette Island, Lightho.	47 49 40	64 53 0		
Shippigan Har., Fall's wh.	47 44 52	64 42 12		
Miscou Island, Lighthouse	47 1 0	64 29 28	24 35	
Shippigan Gully, N. entr. .	47 43 24	64 39 36		
Tracadie, N. Gully, Lighthouse	47 33 20	64 51 25		
Tabisintac Gully, Lightho.	47 17 35	64 56 50		
Escuminac Pt. Lighthouse .	47 4 32	64 47 30	23 10	
Richibucto Head, Lightho	46 39 40	64 42 30		
Buctouche River, Station at entrance	46 26 55	64 37 45		
Cocagne Head, ext. of Cliff	46 21 31	64 31 41		
Shediac, Episcopal Church	46 14 15	64 33 32		
Cape Tormentine, N.W. extreme of Jouremain Id...	46 10 6	63 42 7		
Tignish Head, Bay Verte, Station	46 0 28	64 1 0		
Pugwash, Episcopal Ch. ..	45 51 14	63 30 18	22 25	
Amet Island, East extreme	45 50 15	63 9 40		
Pictou Harbour, Lightho. .	45 41 25	62 39 10		
Pictou Island, Lighthouse, East End	45 49 50	62 29 54		
Cape George, Station in Ballantine Cove.....	45 51 49	61 54 32		
Antigonish Harbour, North Beacon	45 41 49	61 52 56		
Pomquet Island, S.E. extr.	45 39 17	61 44 5		
Gut of Canso, Light, North entrance	45 41 42	61 28 42	23 45	
PRINCE EDWARD ISLAND.				
North Point extr. of Cliff..	47 3 45	63 59 20		
West Point, Lighthouse ..	46 37 30	64 23 10		
Cape Egmont, Station on extreme	46 24 11	64 9 39		
Bedeque Harbour, Green's Wharf.....	46 23 32	63 47 10		
Cape Traverse, extreme of Cliff	46 13 17	63 38 51		
St. Peter's Island, Station S.W. extreme.....	46 6 59	63 11 29		
Charlottetown, Flagstaff on Fort .....[8]	46 13 55	63 7 7		
Prim Point Lighthouse ..	46 3 10	63 1 50		
Panmure Id., Lighthouse..	46 8 47	62 27 24		

GULF AND RIVER OF ST. LAWRENCE—Continued.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
East Point, Station on extreme of Cliff	46 27 15	61 57 42	24 50	The Surveys by Admiral H. W. Bayfield, 1827-60, and Comm. Orlebar, R.N.
St. Peter's Harbour, Sandhill, E. side of entrance	46 26 44	62 43 56		
Tracadie Harbour, Lightho.	46 25 20	63 2 30		
Grenville Harbour, Lightho.	46 31 0	63 29 0		
Richmond Bay, Station on Royalty Point	46 34 45	63 1 50		
Cascumpeque Harb., Light	46 48 22	64 2 0		
Cape Kildare, extreme	46 52 57	63 57 44	23 45	
CAPE BRETON ISLAND.				
Bear Head, extreme	45 33 5	61 17 5	24 5	
Plaster Cove, North end of Bridge	45 38 56	61 23 36		
M'Keen Point, extreme	45 38 51	61 23 54		
Port Hood, Harbour Light at South entrance	46 0 0	61 31 40		
Sea Wolf Island, Lighthouse on summit	46 21 30	61 15 33		
Chetican Point, S. extreme	46 36 22	61 2 58		
Cape St. Lawrence, N. ext.	47 2 54	60 35 36		
Cape North, N. extreme	47 2 35	60 24 56	26 50	
Cape Egmont, E. extreme	46 51 1	60 18 3		
Inganish, Archibald Point	46 41 31	60 21 18		
St. Anne Harb., Beach Pt.	46 17 41	60 32 25		
Ciboux Is., Lighthouse	46 23 12	60 22 30		
Carey Point, W. side of entrance of Gt. Bras d'or	46 11 41	60 24 50		
Cunet Point, extreme	46 20 32	60 17 16		
Sydney Harbour, Lightho. on Flat Island	46 16 12	60 7 22		
Table Head, extreme	46 13 14	59 57 4		
Flint Island, Lighthouse on N.E. end	46 11 5	59 45 50		
Scatari Island, Lighthouse	46 2 13	59 40 18	25 45	
Menadou Harbour	46 0 29	59 49 58		
Cape Breton, extreme	45 57 14	59 47 3		
Gabarus Bay, Ch. on Cape	45 42 7	60 5 3		
Louisbourg, Lighthouse	45 54 34	59 57 15		
Michaux Point, Station on extreme	45 34 11	60 41 0		
L'Ardoise, R. C. Church Steeple	45 36 45	60 45 59		
St. Peter Island, S.W. ext.	45 34 54	60 48 39		
St. Peter Bay, Old Fort on West side of Haulover	45 39 21	60 52 4	24 40	
Madame Island—				
Grande-digue Lennox Passage, Station	45 35 49	61 1 11		
Arichat Harb., Jerseyman Id., N. extreme	45 30 25	61 3 7	24 15	
———; Lighthouse Marache Point	45 29 2	61 1 52		

NOTES.

1. GULF OF ST. LAWRENCE.—Among the difficulties of the navigation in the Gulf of St. Lawrence are the fogs and ices. In spring, the entrance and eastern parts of the gulf are frequently covered with ice, and vessels are sometimes beset for many days. Being unfitted for contending with this danger, they often suffer from it, and are occasionally lost; but all danger from ice is far less than that which arises from the prevalence of fogs: these may occur at any time during the open or navigable season, but are most frequent in the early part of summer. They are rare, and never of long continuance, during westerly winds, but seldom fail to accompany an easterly wind of any strength or duration. This observation is, however, subject to restriction, according to locality or season. Thus winds between the South and West, which are usually clear weather winds above Anticosti, are frequently accompanied with fog in the eastern parts of the gulf. Winds between the South and East are almost always accompanied with rain and fog in every part. E.N.E. winds above Cape de Monts, at the mouth of the river, are often E.S.E. or S.E. winds in the gulf, being changed in direction by the high lands of the South coast, and have, therefore, in general the same foggy character. This is said of winds of considerable strength and duration, and which may extend over great distances. Moderate and partial fine weather winds may occur without fog at any season, and in any locality. In the early part of the navigable season, especially in the months of April and May, with clear weather, N.E. winds are of frequent occurrence, and they sometimes occur at other seasons, and in every part of the gulf and river.

The fogs sometimes last several days in succession, and to a vessel either running up or beating down, during their continuance, there is no safe guide but the constant use of the deep-sea lead, with a chart containing correct soundings.

The fogs which accompany easterly gales extend high up into the atmosphere, and cannot be looked over from any part of the rigging of a ship. They, however, are not so thick as those which occur in calms after a strong wind, and which are often so dense as to conceal a vessel within hail; whilst the former frequently admit the land or other objects to be distinguished at the distance of half a mile or more, in the daytime.

The dense fogs which occur in calms, and even in very light winds, often extend only to small elevations above the sea; so that it sometimes happens, when objects are hidden at the distance of 50 yards from the deck, they can be plainly seen by a person 50 or 60 ft. up the rigging. In the months of October and November, the fogs and rain that accompany easterly gales, are replaced by thick snow, which causes equal embarrassment to the navigator.—*Admiral Bayfield.*

2. The ISLAND OF ST. PAUL lies N. 52° E., *true*, 10 miles from Cape North; it is about 1¼ mile in length from North to South, and inclining to the southward at the North end. Its average breadth is about a quarter of a mile. The margin is rocky and precipitous almost all round, indented on the N.E. and N.W. sides by two coves, both of which afford shelter during the prevalence of certain winds.

3. The MAGDALEN ISLANDS.—These islands have been surveyed by Lieut. P. E. Collins, in 1833, and a beautiful chart of them has been published by the Admiralty. They form an irregular group, and are named respectively *Entry Island*, *Amherst*, *Grindstone*, *Alright*, *Wolfe*, *Grosse*, and *Coffin Islands*; exclusive of *Byron* or *Cross Island*, and the *Bird Islets*, which lie more to the North. Of these, Amherst is the most southern and principal island, but Entry Island is the highest, and is 580 feet above the sea, visible from 8 to 9 leagues off.

4. ANTICOSTI.—This island, with one exception, has no bay or harbour capable of affording shelter to shipping in general. It is uncultivated; yet, rude and unhospitable as its aspect may be, it is not absolutely unprovided with the means of succouring the distress of such as suffer shipwreck on its coasts, there being government agents, who reside upon it (and, with the lighthouse keepers, are the sole inhabitants), at different stations, all the year, furnished with provisions for the use of those who have the misfortune to need them.

Boards are placed in different parts, describing the distance and direction to these friendly spots; these establishments were first made in the year 1809.

"One of these provision posts is at 2 leagues to the S.E. from the West end of the island, in Ellis's Cove or Grand Bay; the second at the lighthouse at the S.W. point; the third at Shallop Creek, otherwise called Jupiter River; and the fourth at the eastern lighthouse on Heath Point."

The South shore of the island is dangerous; but, to modify its character, *four* beacons have been erected—1. With a small triangular head, 40 feet high, on the South point. 2. At Pavillon River, large triangle, with cross over it. 3. Six miles East of Salt Lake Bay, large triangular head. 4. On Cape St. Mary, with a cross (1851).

5. LABRADOR.—The Descriptions and Directions by Capt. Bayfield, of this hitherto but little-known region, are given in the *British American Navigator*. A part of the coast was re-examined by Capt. Chimmo, R.N., in 1867.

6. QUEBEC.—In the early editions of this work the longitude of Quebec was stated to be 71° 10′, "according to the observations of M. le Marquis de Lotbinière, M. Bédard, Director of the Seminary of St. Louis, and Captain Holland. M. Mechain computed the longitude to be 71° 10′, by several eclipses of Jupiter's first satellite, observed by Messrs. Lotbinière and Holland, and the passage of Venus, that Captain Holland observed in 1769. All the observations, made at different times, have given very coherent results."—Vide *American Trans.*, vol. i., &c.

The above passage, from "Analysis of a General Chart, &c., Paris, 1786, shows the position in which Quebec was laid down in the charts, and it agreed with that given in the "Connaissance des Temps." But Quebec was afterwards exhibited considerably more to the eastward. Mr. Wright, in his chart of 1807, made it 70° 27′. The Requisite Tables, of 1802, gave latitude 46° 48′ 38″, longitude 71° 5′ 22″. Colonel Bouchette, in his work on Canada, 1815, gives 46° 48′ 49″ N., and 71° 11′ W. In the years 1819, 1820, and 1821, the officers of H.M.S. *Newcastle*, provided with four chronometers, made many observations in the river, and these observations may be judged of by the longitude they placed Quebec in for three successive years, assuming Halifax as in 63° 33′ 40″; July 16th, 1819, 71° 12′ 48″; June 19th, 1820, 71° 13′ 14″; July 5th, 1821, 71° 12′ 25″. The greatest difference is 49′, and the mean of the whole is 1″ farther West than longitude given in 1819.

From these and other observations combined, the late Mr. Purdy placed Quebec in longitude 71° 13′, in the charts, &c., which he constructed, as they still remain.

When the charts of Captain H. W. Bayfield were published in 1837, they were based upon a longitude of 71 °16′ W. for Quebec. This was shown to be in error nearly 3½ minutes of arc, by electric telegraphic signals transmitted between Quebec and Cambridge Observatory, in Massachusetts, by Lieutenant E. D. Ashe, R.N., in September and October, 1857.

The position of Cambridge, as will be seen in the Note on that longitude on a subsequent page, is definitely settled as 71° 7′ 58″.55, and the mean difference between that Observatory and the Observatory in Mann's Bastion in the Citadel of Quebec, as determined by Lieut. Ashe, is 0° 4′ 34″.17, which places Quebec in 71° 12′ 32″.72.

7. MONTREAL.—The longitude of Gate Island, opposite the Cathedral and the Hotel Dieu, is given by Captain Bayfield in 73° 34′ 38″ (erroneously on Admiralty Charts, as 68° 54′ 48″).

Lieutenant Ashe, R.N., as stated above, in continuation of his work on electric time-signals, obtained the difference of longitude between Quebec and Viger Square, 630 feet West of Gate Island, on March 12th, 1857, as 2° 20′ 45″.5, which makes it in longitude 73° 33′ 18″.12, as shown in the Table.

8. CHARLOTTETOWN and PRINCE EDWARD'S ISLAND.—The position of the flagstaff in the Fort of Charlottetown, has been given by Rear-Admiral Bayfield as 46° 15′ 55″, long. 63° 7′ 23″ W. It had been before placed 3′ more to the West, but the exact difference of longitude between this point and Quebec, has lately been determined by the electric telegraph as 8° 5′ 26″.

The VARIATIONS OF THE COMPASS are *decreasing* at the rate of 5′ or 6′ per annum.

14.—NOVA SCOTIA, ETC.—(Southern Coasts.)

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
SABLE ISLAND [1]	° ′ ″	° ′ ″	° ′	The Surveys by Admiral H. W. Bayfield, and Commanders Shortland and Orlebar, R.N., 1827-60.
Lighthouse 1½ mile from East end	43 58 30	59 46 0	22 50	
Lighthouse on West end	43 57 0	60 8 0		
The MAINLAND [2]				
Cranberry Is., Lightho.	45 19 45	60 55 54		
Canso Harbour, Cutler Id., S.E. extreme	45 20 42	60 59 27	23 45	
„ Steeple of Church	45 20 10	60 59 25		
White Head Id., Lt.-ho.	45 11 58	61 8 27		
White Haven, Observation Station in Marshall Cove	45 14 37	61 11 43		
Berry Head, Lighthouse	45 11 40	61 18 40		
Mew Harb. Head, Nob	45 9 7	61 28 21		
Green Id., Lightho. on South pt.	45 6 15	61 32 30		
Harbour Id., N.E. Point	45 8 25	61 36 43		
Isaac Harb., Red Head, summit	45 9 39	61 38 52		
Country Harbour, station opposite Window Pt.	45 14 41	61 47 6	23 0	
Hollins Head, summit	45 4 19	61 44 57		
Wedge Island, beacon	45 0 36	61 52 47		
St. Mary River, above Episcopal Church	45 6 12	61 58 7		
Liscomb Island, Lightho.	44 9 20	61 57 50		
Mary Joseph Harbour, Lobster Pt., extreme	44 57 52	62 4 57		
Beaver Island, Lighthouse	44 49 33	62 20 38		
Salmon River, West of wharf	44 54 32	62 23 33		
Sheet Harb., ¼ mile N.W. from Watering Cove	44 54 11	62 30 37		
Taylor Head, summit	44 47 24	62 33 8		
Pope Harbour, Harbour Island, Lighthouse	44 47 40	62 38 50	21 45	
Ship Harbour, Islet near Salmon Point	44 46 59	62 49 13		
Egg Island, centre	44 39 55	62 52 9		
Jedore Harb., Marsh Pt.	44 43 19	63 0 39		
Jedore Rock, centre	44 39 49	63 0 57		
Jedore Head, point	44 40 22	63 3 14		
Graham Head, summit	44 37 44	63 17 23		
Devil Island, Lighthouse	44 34 48	63 27 51		
Halifax Harbour, Lighthouse, Maugher Beach	44 36 6	63 32 18	21 5	The Surveys by Admiral Bayfield, 1853.
Grahams Head, summit	44 37 44	63 17 23		
Laurenceton Head, summit	44 38 34	63 21 35		
HALIFAX, Dockyard Observatory [3]	44 39 38	63 35 35		

NOVA SCOTIA, ETC.——CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Sambro Island, Lightho.	44 26 11	63 33 40		
Betty Island, Lighthouse	44 26 20	63 45 50		
S.W. Island, on the W. side of St. Margaret's Bay	44 30 10	63 59 33		The Surveys by Commander Shortland, R.N., Admiral Bayfield, and Commander Orlebar, R.N., to 1867.
Green Island, off Mahone Bay, centre	44 22 55	64 2 50		
Cross Island, off Lunenburg Harbour, Lighthouse	44 18 43	64 9 55		
Cape Le Have, W. Ironbound Id., Lighthouse	44 13 43	64 16 20	19 55	
Medway Head, Admiralty Head, Lighthouse	44 6 10	64 32 15		
Coffin's Island, Lighthouse, near Liverpool Harbour	44 1 58	64 37 30		
Mouton Island, S. Rock	43 52 55	64 45 25		
Shelburne or Cape Roseway, Lighthouse on Macnutt Island	43 37 17	65 15 45		
Negro Island, Lighthouse	43 30 55	65 21 0		
Baccaro Point, Light on W. side of Port Latour	43 26 54	65 28 12		
Brasil Rock	43 21 25	65 26 48		
Cape Sable, Lighthouse	43 23 20	65 37 10		
Seal Island, Lighthouse, half mile from South Point [4]	43 23 34	66 0 50		The Survey by Captain P. F. Shortland, R.N., 1860-2.
Cape Fourchu, near Yarmouth, Lighthouse	43 47 30	66 9 20		
Bryer's Island, Lightho.	44 14 57	66 23 32	18 10	
Point Prim, Lighthouse (entrance of Annapolis Basin)	44 41 30	65 47 10		
Black Rock Pt., Lightho.	45 10 10	64 45 50		
Horton Bluff, Lighthouse	45 6 30	64 13 20		
Partridge Island, in the Mines Channel	45 21 50	64 20 10		
Cape Chignecto	45 19 35	64 56 45	20 55	
NEW BRUNSWICK.				
Hillsborough Light	45 55 15	64 38 0		
Cape Enragé, Lighthouse	45 35 35	64 46 55		
Quaco Head, Lighthouse	45 19 20	65 31 55		
Cape Spencer, Lighthouse	45 12 30	65 54 0		
Partridge Id., Lighthouse	45 14 3	66 3 5		
CITY of ST. JOHN	45 15 30	66 3 15	19 50	Lieutenants Harding and Kortright, R.N.
Point Lepreau, Lighthouse	45 3 30	66 27 39		
Beaven Harbour, Lightho.	45 3 45	66 44 0		

NOTES.

1. SABLE ISLAND.—On this island is an establishment for the relief of shipwrecked mariners. It was founded, in 1803, by the Provincial Legislature at Nova Scotia, at the

recommendation of the late Sir John Wentworth, then Lieutenant-Governor; and has since proved the means of saving many lives.

2, NOVA SCOTIA.—The coasts of Nova Scotia have been heretofore laid down from the surveys of Mr. Des Barres, with emendations by Mr. A. Lockwood, R.N., and various corrections in position by Admiral Owen and others. Since the completion of the survey of the Canadian coasts, our Admiralty Surveyors, Admirals Bayfield and W. F. Owen, with Captains Shortland and Orlebar, have re-examined the S.E. shores of Nova Scotia and the Bay of Fundy, the results of which are shown in the Table.

3. HALIFAX.—In former editions of this work the following appears:—"The latitude of the Naval Yard of Halifax, from observations very carefully made by the officers of H.M.S. *Niemen*, in 1842, was 44° 39′ 37″. This was gained by eleven *meridian* altitudes with the artificial horizon, and several observations made on each side of noon at small intervals; the mean true altitudes being computed from the hour angles. The longitude, 63° 33′ 43″, was obtained as the mean result of more than 30 sets of lunar distances. We formerly gave the longitude of M. Des Barres, &c., as 63° 32′ 40″, and therefore presume that a statement of 63° 37′ 48″, which has lately appeared, is 4′ too far West."

Captain Bayfield, as above stated, assumed the longitude of the Dockyard, in his survey, to be 63° 37′ 48″. The late Admiral W. F. Owen, in H.M.S. *Columbia*, in 1844, made it 63° 35′ 28″ W. The late respected Lieutenant Raper makes it, as a secondary meridian, 63° 37′ 36″, or as Captain Bayfield.

Recent observations show that M. des Barres' longitude is as near the truth, accidentally perhaps, as that resulting from the refined operations of Admiral Bayfield, a mean between the two positions being that which must now be adopted.

In the determination of this, and of other longitudes, the Electric Telegraph has decided the question beyond controversy.

The difference of longitude between Cambridge Observatory, Massachusetts, and that of Halifax Dockyard, has been determined, electrically, by Professor Bond, and Captain Shortland, R.N., to be $0^h\ 30^m\ 9^s$ in time, or 7° 32′ 23.45″ in arc. This meridional difference applied to the determined longitude of Cambridge, as shown in the note, or 71° 7′ 58.55″, makes Halifax Dockyard Observatory to be in 63° 35′ 35″ W. of Greenwich.

4. SEAL ISLAND.—"M. Des Barres places the southernmost point of the southern Seal Isle in lat. 43° 25′ 25″, and long. 66° 0′ 35″. Later charts have it in lat. 43° 26′ 35″; but our correspondent, Lieut Hare, gave the latitude of the South point 43° 22′ 23″, or *four miles more to the southward.* This result, since confirmed, will account for so many ships having been yearly cast away, on coming out of the Bay of Fundy. A very strong indraught, both on the ebb and flood, sets toward the isles, and in the vicinity, equal to 4 knots an hour, and *they should not be approached without a commanding breeze.*" The lighthouse will obviate this.

The VARIATIONS of the COMPASS are *increasing* at an annual rate of about 4.5′.

15.—THE UNITED STATES.

	LAT. N.	LONG. W.	VAR. WEST, 1878 9	AUTHORITIES.
MAINE.	° ′ ″	° ′ ″	° ′	
Passamaquoddy Bay, Light on Quoddy Head	44 49 0	66 57 0	18 40	The Surveys by S. Holland, Esq., with subsequent corrections.
Little River, Light at entrance	44 39 22	67 10 35		
Machias Seal Ids., Lighthouse on E. one (Brit.)..	44 30 0	67 5 30		

THE UNITED STATES—CONTINUED

	LAT. N.	LONG. W.	VAR. WEST, 1878 9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Machias Bay, Lt. on Libby Island	44 30 4	67 21 12		
Moose a-bec or Moose Peak, Mistake Island Light	44 28 52	67 31 43		
Petit Manan, Lighthouse on S. end	44 22 0	67 52 0		
Mount Desert Island, S.E. end	44 18 20	68 10 15		The TRIANGULATION made for the UNITED STATES' COAST Survey, under the superintendence of Professor A. D. BACHE.
Mount Desert Rock, Light	43 59 30	68 4 41	16 5	
sIle au Haut, Light on Saddle Back Islet	44 1 47	68 43 49		
Matinicus Rock, Lightho.	43 51 15	68 47 58		
PENOBSCOT BAY, Ragged Mountain on West side	44 12 44	69 9 12		
———, Owls' Head Lighthouse	44 6 10	69 0 59		
Manheigan Island, Lighthouse	43 46 15	69 18 25	14 40	*** The Stations of the primary triangulation are distinguished by small CAPITALS.
CAPE SMALL, Station 5 miles North of Cape	43 46 42	69 50 54		
Portland Head, Lighthouse	43 27 22	70 12 38		
Cape Elizabeth, E. Light	43 36 56	70 12 10		
FLETCHER'S NECK, Light on Wood Island	43 27 23	70 19 54	13 20	
Cape Porpoise Harbour, Light on Goat Island	43 20 0	70 28 14		
Cape Neddick, Station	43 10 1	70 36 7		
York Harbour, Light on Boon Island	43 7 15	70 28 44		
NEW HAMPSHIRE.				
Agamenticus Hill, Station on summit	43 13 23	70 41 41	12 40	
Portsmouth Harb., Whales Back Light	43 3 30	70 42 3		
ISLES OF SHOALS, Station near Hog Island Harb.	42 59 13	70 37 4		
——, White Is. Lighthouse	42 59 0	70 37 39	12 45	
MASSACHUSETTS.				
Newbury Port, East Light on Plum Island	42 48 25	70 49 15		
Cape Ann, North Light on Thatcher Island	42 38 19	70 34 39		
——, Light on E. point	42 34 47	70 40 28		
Baker's Island, Lighthouse	42 32 10	70 47 25		
Marblehead, Light at entrance	42 30 18	70 51 5		
Nahant, Hotel	42 25 7	70 54 34		
BOSTON, State House [1]	42 21 28	71 4 5	11 40	
———, Cunard Wharf; Flagstaff	42 21 48	71 2 40		
CAMBRIDGE Observatory, Dome [2]	42 22 51	71 7 58		*** For the purposes of the Survey, the coast of the United

THE UNITED STATES—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Boston Bay, Lt. on Little Brewster Island	42 19 39	70 53 40		The Great TRIANGULATION made for the UNITED STATES' COAST SURVEY, under the superintendence of Professor A. D. Bache.
——, Minot's Ledge, Light	42 16 9	70 45 48		
Scituate, Unitarian Church	42 11 59	70 45 36		
Plymouth Harbour, Pier Head	41 58 44	70 39 27		
Sandwich, Church Spire	41 45 26	70 30 14		States is divided into eleven sections (nine of which are on the Atlantic Coast), in all of which the work was carried on simultaneously, the Survey being in different stages of progress in the several sections. These several sections are defined as follows:—Section I., from Passamaquoddy Bay to Point Judith. Section II., from Point Judith to Cape Helopen. Section III., from Cape Henlopen to Cape Henry. Section IV., from Cape Henry to Cape Fear. Section V., from Cape Fear to the St. Mary's River. Section VI., from the St. Mary's River to St. Joseph's Bay. Section VII., from St. Joseph's Bay to Mobile Bay. Section VIII., from Mobile Bay to Vermilion Bay. Section IX., from Vermilion Bay to the Rio Grande. Section X., Coast of California, San Diego Bay, to 42nd parallel. Section XI., Coast of Oregon, 42nd to 49th parallel. The Tables give the latitudes and longitudes of the trigonometrical points in each section. The manner in which these data have been obtained may be briefly explained here.
Barnstaple, Beach Point Light	41 43 19	70 17 7		
Billingsgate Pt. Lighthouse	41 51 37	70 4 34		
Cape Cod, Provincetown, Orthodox Church Spire	42 3 2	70 11 31	11 50	
——, Race Point, Lightho.	42 3 42	70 14 51		
——, Highlands Lightho.	42 2 21	70 3 53		
——, Nausett Centre Light	41 51 36	69 57 48		
Monomoy Island, Light at S. end	41 33 33	69 59 53		
Nantucket Island, CLIFF West of Harbour	41 17 33	70 7 7		
——, S. towered Church	41 16 54	70 6 11		
——, Light on Great or N.E. Point	41 23 22	70 2 59		
——, Sankaty Head Light	41 16 15	69 58 10		
——, Tuckanuck, Telegraph at W. end	41 18 12	70 15 13		
Davis South Shoal, Light-vessel, about	40 56 10	69 51 30	11 10	
Muskeget Island, N.E. pt.	41 20 12	70 18 13		
Martha's Vineyard, Cape Poge Lighthouse	41 25 14	70 27 20		
——, Edgartown, Spire	41 23 16	70 31 20		
——, Holmes' Hole, Spire	41 27 13	70 36 34		
——, West Chop, or North Point Light	41 28 55	70 36 26		
——, INDIAN HILL on N.W. side	41 25 44	70 40 55		
——, Gay Head, Lightho.	41 20 52	70 50 23		
No Man's Land, Station on centre	41 15 9	70 49 4		In each section a base line of from five to ten miles in length is measured with all possible accuracy. A series of triangles, deriving the length of their sides from this base, is then established along the coast, by the measurement of the angles between the intervisible stations. In this primary series the triangles are made as large as the nature of the country will permit, because the liability to error increases with the number of triangles. On the bases furnished by the sides of the primary triangles, a secondary triangulation is next established extending along the coast, and over the smaller bays and sounds, and determining a
Cuttyhunk, Light on S.W. Point	41 24 50	70 57 15		
Nashon Island, Station	41 29 23	70 44 48		
Nobska Lighthouse	41 30 55	70 39 36		
Mattapoiset, Lt. on Ned's Point	41 39 1	70 48 1		
New Bedford, Fort	41 37 25	70 54 25		
Seconnet Point, East Rock	41 27 2	71 11 53		
RHODE ISLAND,				
Newport, Spire	41 29 12	71 19 5	10 15	
——, Beaver Tail Light	41 26 54	71 24 15		
QUAKER HILL, near North End	41 34 55	71 15 31		
Bristol, Court House	41 40 10	71 16 46		
Providence, Unitarian Ch.	41 29 26	71 24 35		
Point Judith, Lighthouse	41 21 28	71 29 10		

THE UNITED STATES—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Block Id., Light on N. Pt.	41 13 27	71 34 38		The Great TRIANGULATION made for the UNITED STATES' COAST SURVEY, under the superintendence of Professor A. D. Bache.
——, Beacon Hill at S. End	41 10 30	71 36 27		
Watch Hill, Lighthouse	41 18 12	71 51 48		
CONNECTICUT AND NEW YORK.				large number of points at distances of a few miles apart.
Long Island Sound:—				The distances between the points thus determined, as given in the Tables, are liable to an average error of about one foot in six miles, until a final adjustment between the base lines shall have been made.
Montauk Point, Lightho.	41 4 13	71 51 42	9 25	
Plum Island, Lightho.	41 10 24	72 12 58		
New London, Presbyterian Church Spire	41 21 16	72 6 5		
Connecticut River, Light on Saybrook Point	41 16 15	70 20 52		
Faulkner's Id., Lightho.	41 12 41	72 39 30		As, on the completion of the primary triangulation in each section, the several series form one connected chain, the different bases afford verifications of each other, and of the triangulation connecting them. The first three sections are thus connected at present.
Newhaven, Episcopal Ch.	41 18 11	72 55 49	8 35	
——, Light on Five Mile Point	41 14 54	72 54 51		
Stratford Point, Lightho.	41 9 5	73 6 29		
Middle Ground Lightho.	41 3 30	73 5 45		
Throg's Neck, Lightho.	40 48 17	73 47 36		
Lands Point Lighthouse	40 51 55	73 44 4		
Eaton's Point, Lightho.	40 57 12	73 23 51		
Old Field Point, Lightho.	40 58 34	73 7 24		
Horton's Point Lightho.	41 5 0	72 26 51		
Long Island, South side, Shinnecock Bay, N. Pt.	40 51 0	72 30 36		
Fire Island, Lighthouse	40 37 53	73 12 51		
NEW YORK, City Hall	40 42 43	74 0 39	7 5	
——, Navy Yard Flagstaff [3]	40 42 2	73 59 6		
NEW JERSEY.				
Sandy Hook, Lighthouse	40 27 39	74 0 24		
Highlands of Navesink, Lt.	40 23 42	73 59 25		
Barnegat Inlet, Lightho.	39 45 49	74 6 41		
Little Egg Harb., Boarding House at North end of Tucker Island	39 30 48	74 18 12		
Absecum Inlet, Light on S. side	39 22 0	74 25 36		
Hereford Inlet, Lighthouse	39 0 0	74 47 0		
DELAWARE BAY.				
Cape May Lighthouse	38 55 50	74 57 51	5 35	
Egg Island Lighthouse	39 10 31	75 8 37		
Cohansey Lighthouse	39 20 18	75 21 45		
Ship John Shoal Lightho.	39 18 15	75 22 40		
PHILADELPHIA, Girard Col.	39 58 23	75 10 30		
„ Navy Yard	39 55 47	75 8 50	6 15	
Wilmington, Lt. at Christiania River	39 43 15	75 31 32		
Bombay Hook, Lighthouse	39 21 46	75 30 55		

THE UNITED STATES—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
Cape Henlopen, High Light	38 46 38	75 5 19	° ′	The Great TRIANGULATION made for the UNITED STATES' COAST SURVEY, under the superintendence of Professor A. D. Bache.
VIRGINIA, &c.				
Indian River, Salt Works	38 35 35	75 3 50		
Assateague Id., Lighthouse	37 54 37	75 21 40		
Hog Id., Lightho. at S. end	37 23 18	75 42 12		
Cape Charles, Lighthouse	37 7 48	75 52 48	3 0	
CHESAPEAKE BAY.				
Old Point Comfort Lt.-ho.	37 0 3	76 18 26		
York Spit Lighthouse	37 12 31	76 15 18		
Wolf Trap Shoal, Lightho.	37 23 13	76 11 35		
Smith's Point Lighthouse..	37 53 38	76 11 44		
Cove Point Lighthouse....	38 23 7	76 22 56		
Thomas Point Lightho. ..	38 54 6	76 25 37		
Baltimore, Lazaretto	39 15 39	76 35 14		
WASHINGTON, Capitol Dome	38 53 20	77 0 51	3 20	
„ National Observatory .. [4]	38 53 39	77 3 23		
NORTH CAROLINA.				
Cape Henry, Lighthouse ..	36 55 29	76 0 48		
Currituck Beach, Lightho.	36 22 32	75 49 53		
Entrance to Pamplico Sound, Body Island Lt. (building)	35 47 21	75 31 20		
Stevenson's Point, N. side of Albemarle Sound..[5]	36 6 18	76 11 3		
Cape Hatteras, High Light	35 15 11	75 30 59	2 0	
„ extremity..	35 14 50	75 31 5		
Ocracoke Inlet, Light on W. end of Island	35 6 31	75 58 51		
Cape Lookout, Lighthouse	34 37 20	76 31 7		
„ extremity..	34 31 50	76 31 36		
Beaufort Inlet, S. Light near Fort Macon	34 41 43	76 40 20		
Bogue Inlet, entr., about ..	34 38 0	77 6 20		
Cape Fear River, Light on Federal Point	33 57 34	77 55 11	Var. E. 0 30	
Cape Fear, Lightho. Bald Head	33 52 18	78 0 15		
„ S. extreme ..	33 49 55	77 57 50		
Little River, entrance	33 49 0	78 30 30		
SOUTH CAROLINA.				
George Town, Light at entrance of Pedee River ..	33 13 21	79 10 53		
Cape Romain, Light on Raccoon Kay.....	33 1 8	79 22 12		
Bull's Bay (Refuge Harb.). Light at N. end of Bull's Island	32 55 20	79 33 44		

THE UNITED STATES—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
CHARLESTON, Main Lt.-ho. on Morris Id., at W. entrance	32 41 44	79 52 58	1 25	The Great TRIANGULATION made for the UNITED STATES' COAST SURVEY, under the superintendence of Professor A. D. Bache.
„ St. Michael's Ch. [6]	32 46 33	79 55 38		
North Edisto River, E. end of Base line, 1¾ mile W. of entrance	32 33 17	80 13 20		
Port Royal, Martin's Industry, Lightvessel	32 5 31	80 35 13		
GEORGIA.				
Savannah River, Tybee Lt.-house	32 1 21	80 50 33	2 30	
„ Exchange Spire	32 4 53	81 5 14		
Sapelo Bar, Blackbeard Id., East Point	31 30 10	81 16 0		
St. Simon's Sound, Light-house on N. side	31 3 46	81 32 29		
St. Andrew's Sound, Light on Little Cumberland Island	30 53 32	81 32 25		
FLORIDA.				
St. Mary's River, Light on N. end of Amelia Island	30 39 26	81 30 54		
Fernandina, railroad wharf	30 40 17	81 27 42		
St. John's River, Lightho.	30 23 40	81 24 40		
St. Augustine Inlet, Light on Anastasia Island	29 50 48	81 19 11		
Cape Canaveral, Light	28 27 0	80 33 0	3 20	
Jupiter Inlet, Lt.-ho. S. of	26 55 26	80 5 5		
Cape Florida, Biscayne Kay [7]	25 41 0	80 9 24		
Florida Reefs, Lighthouse on Fowey Rocks	25 35 20	80 5 50		
„ Alligator Reef Lt.-ho.	24 51 2	80 37 10		
„ Sombrero Shoal Lt.-h.	24 37 36	81 6 43		
„ Sand Kay Lighthouse	24 26 30	81 52 42		
Key West, Light on S.W. Point	25 32 32	81 48 7	4 20	
„ Tifts Observatory	24 33 31	81 47 0		
Marquesas, S.E. Point	24 32 54	82 5 32		
Dry Tortugas, Lighthouse on Bush Kay, Fort Jefferson	24 37 47	82 52 53		
Cape Sable, Fort Poinsett	25 6 0	81 9 0		
Cape Romano	25 51 0	81 57 0		
Sanibel Island, East	26 27 30	82 10 0		
Tampay Bay, Egmont Kay Lighthouse	27 36 0	82 45 15		
Anclote Kays, Inlet	28 17 0	82 54 0		
Cedar Kays, Lightho. on Seahorse Kay	29 5 45	83 4 50	4 10	
St. Mark's Harbour, Light-house	30 4 24	84 10 37		

THE UNITED STATES—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	°	
Dog Id., Lt. near W. end..	29 46 0	84 34 42		The Great TRIANGULATION made for the UNITED STATES' COAST SURVEY, under the superintendence of Professor A. D. Bache.
Cape St. George, Lightho..	29 36 10	84 58 38		
Cape St. Blas, Lighthouse	29 41 41	85 24 34		
Pensacola Bay, Lighthouse	30 19 0	87 17 24	5 50	
ALABAMA.				
Mobile Point, Fort Morgan [8]	30 13 48	88 0 25	6 10	
Dauphin Island, West end Station of base	30 14 27	88 13 53		
Mobile, Episcopal Spire ..	30 41 26	88 1 29		
Horn Island, East Point ..	30 13 21	88 30 58		
MISSISSIPPI & LOUISIANA				
Ship Island, Lighthouse on W. Point.....	30 12 55	88 57 1		
Chandeleur Island, Lighthouse on N. Point.....	30 3 22	88 51 49		
Entrance of the Mississippi, Pass a Loutre Lighthouse	29 8 36	89 1 30	7 5	
„ S.W. Pass Lighthouse	28 58 28	89 21 0		
NEW ORLEANS, City of [9]	29 57 30	90 2 18		
Timballier Bay, Lighthouse on W. side of entrance..	29 4 0	90 16 30		
Atchafalaya Bay, Point au Fer	29 19 30	91 33 0		
Sabine River, Lighthouse on Brant Point	29 43 55	93 50 19		
TEXAS.				
Galveston Bay, Lighthouse on Bolivar Point	29 22 35	94 45 40	8 55	
Galveston, Court House ..	29 18 14	94 46 33		
Matagorda Island, Lighthouse on E. Point.....	28 20 58	96 23 57		
Aransas Pass, Lighthouse on N. side	27 23 53	96 56 30		
Brazos Santiago, Lightho. on Isabel Point.....	26 4 52	97 11 4	8 40	

NOTES.

GENERAL NOTE.—In the year 1807, the United States' Legislature determined upon the survey of the coast. This was not properly commenced until 1817, when some base lines were measured, and triangles taken. In 1832 the operations were resumed, under its original superintendent, Mr. F. R. Hassler.

In 1842 a plan was drawn up by Congress for its further organization, under which it has since continued under the able superintendence of Professor A. D. Bache. In the conducting of this extensive survey, every refinement and appliance to ensure accuracy is employed, and many new and important discoveries in geodetic science have been made.

The latitudes and longitudes of the points between Mount Desert Island, in Maine, and the Chesapeake, are connected together in the triangulation. South of this, the survey has only been carried on in detached portions, as stated in the respective notes, and their points given are dependent on the accuracy of the position of the primary station in each section.

As shown in the Note on pp. 60-2, the whole of the coasts of the United States is divided into eleven sections, of which two are composed of the Pacific Coasts, and the geographic connexion between America and the rest of the world, is mainly dependent on the position of the Observatory of Cambridge near Boston.

The positions given are taken from a list of nearly 4,000 points, established in the course of the survey, as published in 1851-3, with a slight subsequent correction. But each place may now be taken by the mariner as absolutely accurate, as the amount of probable error is so small, as to be totally beyond his means of detecting. Therefore each lighthouse, cape, &c., will equally well serve to correct his reckoning, or rate his chronometer, as the primary observatory.

1. BOSTON.—Dr. Bowditch, from six astronomic observations, viz., two transits and four solar eclipses, made the longitude of Boston as $4^h\ 44^m\ 16^s{\cdot}6$; and it was the opinion of Dr. Bowditch that this longitude was more accurately ascertained than that of any other place in the United States. The State of Massachusetts was surveyed trigonometrically, by Simeon Borden, and Robert Treat Payne, Esqrs., and the survey was based on the position of Boston State House. "From observations in 1829 and 1830," says Mr. Borden, "I made the longitude of the State House as $4^h\ 44^m\ 14^s{\cdot}6$, and by the great solar eclipse, May 15th, 1836, $4^h\ 44^m\ 19^s{\cdot}6$; mean of the whole, 71° 4′ 13″.5, or only 8″ more than in the Table. The latitude deduced as 42° 21′ 22″.7, was from 636 observations.

2. CAMBRIDGE OBSERVATORY.—The longitude of the Observatory of Cambridge near Boston, is the primary meridian of the greater portion of N.W. America, inasmuch as the longitudes of most other places have been referred to it by triangulation, or by electric signal. Its relation to Greenwich has also employed years of assiduous labour and consummate skill, and may now be considered as entirely established, within probably an insignificant amount of error.

Prior to the year 1849, the astronomic observations systematically carried on there had resulted in a longitude assumed as 71° 8′ 0″.0 West of Greenwich. When the positions of the United States' Coast Survey Stations were published in 1851, it was assumed as 71° 7′ 22″.5, from the following data:—Moon culminations at various observatories referred to Cambridge, $4^h\ 44^m\ 28^s{\cdot}4$; by eclipses and occultations in the same manner, $4^h\ 44^m\ 29^s{\cdot}6$; and by chronometric differences to that date $4^h\ 44^m\ 30^s{\cdot}1$. This latter determination was afterwards assumed by Professor Bond to be very nearly the true longitude.

But in 1855 the chronometric operations were again resumed early in January, and the first meridional distance was carried by the steamer *America*, June 5th, and the last by the return of the *Africa* to Boston, October 26th, 1855. There were six voyages across the Atlantic, between Boston and Liverpool, and the total number of chronometers used was fifty-two, and the final longitude determined is as follows:—

	h	m	s
Voyages from Liverpool to Cambridge	4	32	31·92
Voyages from Cambridge to Liverpool	4	32	31·75
Mean	4	32	31·84
Liverpool West of Greenwich		12	0·05
Resulting longitude	4	44	31·89 or

Cambridge 71° 7′ 58″.55 West of Greenwich, which is here assumed. This longitude, which is $1^s{\cdot}79$ in excess of the longitude of 1851, is a very close approximation to that established by Dr. Bowditch and Mr. Borden for Boston as in the previous note, and is also nearly

identical with that of New York, as obtained by Mr. Dent's chronometers in 1839. For these reasons the result of 1855 has been preferred, and 36″ has been added to the longitudes given in the extensive tables published by the United States' Coast Survey department in 1851, above alluded to.

The longitudes in Sections I, II, III, and V, of the United States' Survey are dependent on this.

3. NEW YORK.—In the *Ladies' and Gentleman's Diary*, or *United States' Almanac*, for 1820, Mr. Nash, the Editor, having the reputation of an excellent observer, gives particulars of a great many meridian and circum-meridional observations taken at his school, Broadway, New York, from which he infers the latitude of No. 331, Broadway, as 40° 42′ 58″. The difference of latitude, trigonometrically found, between Mr. Nash's and the City Hall, was somewhat less than 1,300 feet, which, assumed as 13″, gives the latitude of the City Hall 40° 42′ 45″, *i.e.*, allowing 40° 42′ 58″, as the latitude of No. 331, Broadway. By observations of a solar eclipse, which Dr. Bowden observed at New York, he found the difference of longitude between Greenwich and Colombia College, equal to 74° 0′ 45″ W. On the 29th of May, 1818, at a few minutes past noon, the longitude of No. 331, Broadway, by the mean of three distances of the sun and moon, appeared to be 74° 0′ 42″, and Mr. Nash adds, "I am inclined for the present, to place the City Hall in 74° W."

By seventy lunar distances, forty of *Pollux* East, and thirty of *Aldebaran* West of the moon, in December, 1822, and January, 1823, *Captain* (afterwards *Genl. Sir Edw.*) *Sabine* gave the longitude of the cupola of Colombia College, New York, as 74° 3′ 27″, and the latitude which he assigns to it is 40° 42′ 43″. Mr. De Witt, on his survey of the province, gave the longitude as 74° 3′.

The chronometers of Messrs. Arnold and Dent, however, appear to have decided the longitude of New York. Four of them were embarked in the *British Queen* steam-vessel, under the care of Captain Roberts, on her first voyage from England to America in July and August, 1839, and gained the longitude of the City Hall in New York, as $4^h\ 56^m\ 3^s{\cdot}35$)=74° 0′ 49″). A second experiment was made on the next voyage of the same vessel, in October and November of the same year, by another set of four chronometers, and by this the difference of longitude between the Observatory at Greenwich and the City Hall, New York, appeared to be $4^h\ 56^m\ 0^s{\cdot}24$, Say 74° 0′ 10″. M. Daussy, the French Hydrographer, had previously given it in the *Connaissance des Temps* as $4^h\ 56^m\ 0^s{\cdot}72$, or 74° 0′ 11″.

By the determination of the United States' Coast Survey, from data up to 1851, it was in longitude 74° 0′ 3″·09; but, by the subsequent correction of the Cambridge longitude as shown above, it is in 74° 0′ 39″, as in the table, very nearly identical with the determination of M. Daussy and Mr. Dent.

4. WASHINGTON.—In our former editions, the Dome of the Capitol is placed in longitude 77° 0′ 20″; from the State Survey of 1816, this is shown to be nearly correct.

SEATON STATION in the City of Washington, is the point to which all telegraphic differences of longitude are referred, and which have now placed it in connection with most of the important places on the coasts of North-west America, and established beyond controversy, their true relative longitudes.

5. NORTH CAROLINA.—The longitudes of the coasts South of Cape Henry, at the Chesapeake, as far as Cape Fear, or Section IV. of the United States' Coast Survey, are dependent on that of Stevenson's Point, the West Point of Little River, on the North side of Albemarle Sound. The Base line upon which the triangulation was established, was measured upon Body's Island, on the coast of Pamplico Sound, and the South end of it is near the Lighthouse.

6. CHARLESTON.—The longitude of Charleston was obtained from Seaton Station, in Washington, by Electric Telegraph, in 1850, by Professor Walker and Lieutenant Gibbes. Section V. of the United States' Coast Survey system is thus connected with the rest of the series.

7. Cape Florida, &c.—In 1845, Captain Edward Barnett, R.N., made a running survey of the Coast of Florida and the adjacent banks. His longitudes found by eight chronometers by meridian distance from Havana, and in other portions of this region have been found very consistent. He placed Cape Florida in longitude 80° 3′ 0″ W.

But the United States' Surveyors make this position a primary point for the longitudes in Section VI. of the Coast Survey, and they made it, according to their estimate of 1851, 80° 5′ 0″, and in 1859, 80° 9′ 29″, or 6½′ further West than Captain Barnett. Yet Sand Kay is placed by the United States' authorities, in November, 1852, as 81° 52′ 43″, while Captain Barnett's longitude is 81° 51′ 12″, a difference of only 1½′.

8. Mobile.—Fort Morgan, on Mobile Point, is made the primary station of Sections VIII. and IX. of the United States' Survey, or between it and the Mexican frontier.

9. New Orleans.—The position of New Orleans is given approximately from the sketch published by the United States' Coast Survey. The triangulation was not entirely completed from Mobile.

The longitude of New Orleans is of some interest. The United States' Coast Survey has assumed a considerable degree of importance from its extent, and these results being extended to the other portions of the territory, render the consideration of a *primary* meridian for the western world one necessary to be determined in the early state of the operations.

The capitol of Washington would naturally appear to be the fittest starting point; but as the introduction of greater diversity in astronomic and other Tables than at present exists is certainly not desirable, the United States' Survey Department commissioned Professor Bache to report on the subject. Impressed with the inconvenience attached to the introduction of a fresh mode of reckoning meridional distances, and at the same time to give due importance to the geodetical operations carried on in America quite independent of any in the eastern hemisphere, he recommended, if any transatlantic meridian were to be assumed as a primary, that of *New Orleans* would be the fittest.

The progress of the survey having shown that New Orleans was in long. 90° 0′ 0″, or nearly so, it became manifest that one objection to a new fractional element being introduced was in some degree removed if this were taken. With this view, if any meridian were to be assumed for the United States, that of 90° West of Greenwich, *wherever it may fall*, is the fittest. in the course of the operations any correction be found necessary to this meridian, as marked in some part of New Orleans, let it be removed accordingly Thus the first meridian of the United States, would be one-fourth of the circumference, or six hours in time West of that of Greenwich.

VARIATIONS OF THE COMPASS.

The question of Magnetic Variation of Declination, has received much attention from the Survey department under the superintendence of Professor Bache, who, with Mr. J. E. Hilgard, have reported on the subject.

The exact observations at present collected, have not been sufficient to establish the exact amount of secular change which is necessary to bring the observed result of former years in accordance with the existing Variation. As the amounts given in Professor Bache's and Mr. Hilgard's Tables are for various epochs between 1844 and 1856. we have taken the secular change at the amounts estimated by Staff-Captain F. J. Evans, R.N., and added them to those quoted in the American list, to bring them down to the epoch 1878-9.

The line of *No Variation* intersects the coast to the westward of Cape Lookout, in about longitude 77° 40′ W.

To the north-westward of this line, the *Westerly* variation is *increasing* about 3′.0 per annum in the vicinity of Cape Hatteras; about 3′.5 per annum near New York, and 4′.0 per annum on the Coast of Maine.

The lines of *equal* variation run about N.W. and S.E. *true* on the coast of Maine; N.W. by W,, and S.E. by E. about New York, and N.N.W. and S.S.E. on the coast of Carolina and Georgia.

The variations to the south-westward are *decreasing* at the rate of 1′ to 1′.5 per annum.

16—.THE BERMUDA ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Ireland Id., entr. of harbour	32 19 15	64 51 40		The Trigonometrical Survey, by Capt. Thos. Hurd, R.N., under the orders of the British Admiralty, between the years 1783 and 1797, adjusted by the observations of Captain Edward Barnett, R.N., 1846, &c.
Somerset Island Beacon ..	32 17 4	64 54 0		
Gibb's Hill Lighthouse, light revolving every minute (362 feet)	32 15 4	64 51 36	7 20	
Castle Island, entrance of Castle Harbour	32 20 18	64 41 50		
St. David's Head (Lightho. *building*)	32 22 0	64 40 30		
Fort Cunningham, at the entrance of St. George's Harbour	32 22 18	64 41 0		
Mill's Breaker, eastern extremity of the reef	32 24 30	64 39 20		
North Rock, northern side of Reef	32 28 20	64 47 45		
Challenger Bank N.E. extr. 47 fathoms	32 7 20	65 4 0		

NOTES.

1. Between the years 1783 and 1797, Captain T. Hurd, R.N., was employed in the survey of these beautiful islands, the outline of which survey is published by the British Admiralty. Captain Hurd deduced his longitudes from Wreck Hill, which, from its position as recently ascertained, may be taken as having been within 4′ or 5′ E. of the correct longitude. In the chart of the Bermuda Islands, as published by Mr. Laurie, we have placed the islands in the longitudes, which, from the accuracy of recent observations, we may suppose to be finally settled.

Ireland Island.—The position of Bastion C, which serves as a groundwork for the rest, was determined by meridian altitudes; and the longitude, we presume, is by chronometer, from the West Indies. The detail of these operations is given by Capt. Edw. Barnett, R.N., in the "Bermuda Royal Gazette," August 25th, 1826.

2. Wreck Hill.—As we have mentioned, Capt. Hurd considered this to be in latitude 32° 15′ 20″, and long. 64° 50′; but, according to the corrected position of Ireland Island flagstaff, this is 1′ 25″ South, and 4′ 40″ E. of its right place.

3. Gibb's Hill Lighthouse.—The position of this was obtained by triangulation from Ireland Island; but, on applying these calculations to Captain Hurd's survey, we find some small discrepancies; but as they are not of sufficient magnitude to affect navigation, we have not attempted to adjust them.

The variation of the compass is *increasing* about 2′ per annum.

17.—THE BAHAMA AND PASSAGE ISLANDS.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
LITTLE BAHAMA BANK.	° ′ ″	° ′ ″	° ′	
MATANILLA, or Maternillo Bank, N.W. end of [1]..	27 23 0	79 8 0	2 10	Captain Edward Barnett, R.N., 1846.
Matanillo Shoal, 12 feet ..	27 22 0	79 4 0		
Outer part of the Western Reef	27 5 0	79 12 0		
Memory Rock	26 57 0	79 6 40		
Settlement Point, W. end of Grand Bahama Island	26 41 30	79 0 35		
S.E. pt. of Grand Bahama.	26 29 0	78 41 30		
HOLE IN THE WALL, Light-house .....[2]	25 51 30	77 10 45	2 5	
N.E. Point of Abaco (so called).....	26 30 0	76 57 0		
Elbow Reef, Outer Point..	26 33 0	76 50 0		
GREAT BAHAMA BANK.				
THE SOUTHERN KAYS—				
The Brothers, East Rock	22 3 30	75 44 0		The Observations of Captain Richard Owen, R.N., 1831—32.
THE JUMENTOS—				
Little Ragged Isle, Beacon	22 9 30	75 44 30	2 15	
Ragged Island, Flagstaff	22 11 40	75 47 17		
Racoon Kay, Beacon ..	22 21 50	75 49 39		
Channel Kay.....	22 32 15	75 52 50		
Jamaica South Kay	22 42 56	75 54 46		
Man of War Kay, N. End.....	22 47 20	75 54 0		
Flamingo Kay	22 52 0	75 53 6		
Water Kay, S.W. Point.	22 58 0	75 45 3		
YUMA OR LONG ISLAND:—				
South Point of the Isle..	22 50 0	74 52 0	1 55	
Great Harb., Entrance..	23 7 0	74 52 30		
Michael Bk., 12 fathoms	23 9 15	74 45 30		
Whale, or North Point..	23 41 37	75 20 0		
EXUMA, the Beacon	23 31 53	75 49 21		
Galliot Cut, on the Bank..	23 55 0	76 15 0		
Eleuthera, S.E. Point	24 37 0	76 9 23		
„ Governor's Harb.	25 11 15	76 14 53		
„ James' Cistern ..	25 21 0	76 23 0		
„ Harbour Island .	25 30 0	76 39 0		
„ Egg Island Reef, Extremity	25 34 0	76 55 30		
THE ISLES, &c. ON N.W.:—				The Surveys of Capt. Richard Owen, Captain E. Barnett, Lieutenant T. Smith, R.N., &c., 1836—1842.
Fleeming Chann., Beacon	25 16 45	76 55 3		
Douglas Chann., Entr...	25 7 30	77 2 45		
NASSAU, New Providence *Lighthouse*.....[3]	25 5 10	77 22 4	2 10	

THE BAHAMA AND PASSAGE ISLANDS—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Joulter Kays; N. extrem. .	25 19 30	78 8 30		The Surveys of Capt. Richard Owen, Captain E. Barnett, Lieutenant T. Smith, R.N., &c., 1836—1842.
ANDROS ISLES: Morgan's Bluff, or N.E. Point . .	25 10 24	78 1 30		
High Kay, on the E. Coast	24 39 30	77 42 50		
Golding Kay	24 13 40	77 37 20		
Green Kay, in the Gulf .	24 2 12	77 10 0		
Berry Isles:—				
S. Stirrup Kay, N.W. Point	25 25 5	77 55 30		
Great Stirrup Kay. Lighthouse	25 49 40	77 53 45		
Holmes' Kay, centre . . .	25 37 40	77 44 0		
Great Isaac, Lightho. [4]	26 2 0	79 6 30	2 25	
Western side of the Great Bank:—				
Moselle Bk., Bemini Is. .	25 49 10	79 17 30		
Gun Kay, Lightho. . . [5]	25 34 35	79 18 50		
Brown's Kay	25 23 40	79 13 0		
S. Riding Rk., Beacon .	24 14 0	79 10 0		
Orange Kays, Middle . .	24 56 30	79 9 24		
Southern part of the Bank:				
Guincho, or Ginger Kay	22 45 0	78 8 0		
Lobos, or Wolf Kay . . .	22 22 50	77 36 0		
Mucaras, or Diamond Point . . . . . [6]	22 10 0	77 19 0		
Cayo Verde, or Green Kay	22 1 40	75 10 0		
Kay of St. Domingo [7]	21 42 20	75 44 45	2 20	
THE PASSAGE ISLANDS.				
Little St. Salvador, W.Pt. . .	24 36 22	75 58 0		
St. Salvador, Columbus or S.E. Point	24 8 30	75 16 48	1 45	
———, Hawk's Nest, or S.W. Point	24 8 50	75 32 30		
———, N.W. Point	24 41 10	75 45 30		
Conception Island, S. end . .	23 48 46	75 6 0		
Southampton Reef, exty . .	23 55 15	75 7 3		
Rum Kay, S.E. White Cliffs	23 38 40	74 47 20		
———, West End . . . . [8]	23 39 0	74 56 35		
Watling's Island; Large White Rock at N. End	24 10 15	74 28 30	1 35	
The S.W. Point	23 56 27	74 34 0		
Hinchinbroke Rock	23 56 40	74 28 33		
Samana or Attwood Kays:				
East Low Kay	23 5 0	73 36 43		
Westernmost Reef, exty.	23 5 50	73 52 0		
Southern Reef	23 4 45	73 45 0		
Planas or Flat Kays, centre	22 35 10	73 33 0		
CROOKED ISLANDS, &c.:—				
The N.E. Breaker	22 43 30	73 47 0		

THE BAHAMA AND PASSAGE ISLANDS—Continued.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
N.E. Reef, Extremity ..	22 47 0	73 49 45		The Surveys of Capt. Richard Owen, Capt. E. Barnett, Lieutenant T. Smith, R.N., &c., 1836—1842.
Mount Pisgah	22 44 10	74 7 33		
Bird Rock Lighthouse ..	22 51 0	74 22 15		
Fortune Isle, or Long Kay, S. Point	22 32 0	74 23 0		
Castle Isle.....[9]	22 7 0	74 18 45	1 55	
Miraporvos :—*				* The Miraporvos Bank and Kays were surveyed by Mr. De Mayne, in 1827. The Bank is eleven and a half miles in extent from S S.E. to N.N.W., and the shoals upon it are very dangerous, particularly to those advancing from the S.E. With the wind blowing strong from the northward they break heavily, and at all times there is a heavy swell upon them. The current generally sets from the N.E. over the shoals at the rate of 1 mile an hour.
North Rock	22 7 50	74 32 40		
South Kay, Sand-hills ..	22 5 0	74 32 15		
Hobart's Breakers, S.E. End	21 58 30	74 27 30		
Diana, or Monkey Bank, centre	22 31 0	74 47 30		
Mariguana, or Mayaguana, S.W. Point	22 21 45	73 9 30		
Eastern End of E. Reef .	22 18 0	72 38 16		
The Caycos:				
Cape Comet, N.E. Point [10]	21 42 50	71 27 38	1 20	The Surveys of Capt. Richard Owen, 1831–32.
Large House near the Booby Rocks	21 49 0	71 41 0		
The Three Maries	21 57 30	72 2 30		
West Caycos, South End	21 37 30	71 44 33		
Providenciales, N.W. Pt.	21 52 40	72 20 3		
West, or Little Cayco, South Point	21 37 30	72 28 33		
West Sand Spit.....	21 22 0	72 5 0		
South Shoal	21 2 0	71 44 33		
Swimmer Shoal.....	21 5 15	71 29 0		
The Hogsties, N.W. Kay	21 41 30	73 50 0		
Great Inagua:—				
The N.W. Point....[11]	21 7 30	73 39 30		
Middle Point	21 1 45	73 41 0		
S.W. Point.....	20 55 0	73 39 3		
Matthew Town	20 58 0	73 39 30		
Lantern Head (82 feet high)	20 56 30	73 19 24		
S.E. Point	20 57 45	73 9 48		
N.E. Point.....	21 20 30	72 59 30	1 45	Remarks.
Little Inagua; East Point .	21 29 15	72 55 33		
„ „ N.W. Point .	21 30 40	73 4 33		Turks' Island Passage.—Near the S.E. end or elbow of the Caycos Bank, is a shoal in lat. 21° 4′, long. 71° 31′ 32″, having over it, in some parts, only 5 feet of water, and lying with a bushy kay on the bank bearing N. by W. (by compass) 6 or 7 miles. Lat. by merid. alt.: long. by two good chronometers, made by Barraud: one giving 71° 31′ 5″; the other, 71° 32′ 6″. —*Edwd. Dunsterville H.M.S. Carnation.*
Turk's Islands :—				
Endymion Reef.....	21 7 15	71 18 18		
Sand Kay, centre	21 11 12	71 14 33	1 20	
Salt Kay, centre	21 20 0	71 12 0		
Grand Kay, Roadstead [12]	21 28 10	71 7 30		
Square Handkerchief, N.E. detached Breaker	21 6 30	70 27 20		
S.E. extremity	20 47 30	70 27 0		
Western extremity	20 56 0	70 57 0		

THE BAHAMA AND PASSAGE ISLANDS—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
SILVER KAY, OR PLATE BANK:—				
East End (10 fathoms)..	20 35 20	69 21 53		The Surveys of Mr. Anthony De Mayne, &c.
S.E. Point	20 13 0	69 35 48		
N.W. Point	20 55 0	69 56 13		
S.W. Point.....[12]	20 17 20	70 0 53	1 15	
BAJO DE NAVIDAD, OR SHIP BANK:—				
Northern Extremity[13]	20 14 0	68 51 18	1 0	
Eastern	20 2 0	68 47 33		
South-West	19 51 50	68 58 16		

NOTES.

1. MANTANILLA BANK.—The Mantanilla Bank, to the northward of the reef, was not represented in Mr. De Mayne's Chart, although given in that of the Spanish surveyors. It was examined by Captain Edward Barnett, R.N., in 1846, and the positions corrected accordingly.

2. HOLE IN THE WALL LIGHTHOUSE is a conical stone tower 160 feet high, the upper part painted red and the lower part white, the lantern is also painted white.

3. NASSAU.—The position appears to be finally settled as in the Table. The Spanish Surveyors gave the town as in 25° 4′ 33″ N., and 77° 19′ 30″ W. Mr. De Mayne as 25° 5′ 18″ N., and 77° 19′ W.

4. GREAT ISAAC.—This islet is moderately high, has several wells of fresh water, and abundance of large shell-fish. The Providence droggers water here.

5. GUN CAY LIGHTHOUSE, 70 feet high, is coloured similarly to Hole in the Wall Lighthouse, as above described.

6. DIAMOND POINT OF THE MUCARAS.—The Mucaras, Lavanderas, and Lobos, with the dangers on the bank in the vicinity, have been surveyed, with great care, by Captain Edward Barnett, whose positions are those given in the Table. This portion of the bank was formerly represented, as in the Spanish Charts, rather more to the South, and 6′ more to the East.

7.—KAY OF ST. DOMINGO.—The southern part of the Great Bank, on which this kay is situate, is very dangerous by night. The kay had formerly the appearance of a sail, but, in 1835, the crew of the *Thunder* erected a beacon of stones, about 15 feet high, upon the centre of it; the other part of the kay is about 5 feet only above the water. It is a rocky, arid spot, producing nothing but a little samphire and wild grass.

8 RUM KAY.—This island was formerly very erroneously represented on the charts, both as to magnitude and position. The white cliffs at the S.E. end are remarkable, and may be seen 6 leagues off.

9. CASTLE ISLE.—The point appears to be finally settled. Former observations gave 22° 7′ 45″ N., and 74° 17′ 30″ W.

10. CAYCOS.—Captain Livingstone says:—"I am perfectly satisfied that any vessel shaping a course from off the rocks to weather the N.W. point of the Caycos by any chart hitherto published, will infallibly get entangled among the reefs on the West side of the Watering Bay. When a vessel once gets embayed among them, it must be next to impossible to beat out; as the reefs extending from the land to the eastward hook suddenly round, at their outer extremity, to the southward. Thus a vessel may be in blue

and deep water while the hook of the reef is outside her. I have three times examined the appearance of these reefs from the mast-heads of different vessels, and each time they appeared to me more dangerous than they had previously done."—(*This was written in* 1848.)

11. GREAT INAGUA.—This island has been surveyed by Lieutenant Lawrence, R.N.—Matthew Town, a new settlement, lies 3 miles northward of the S.W. point. On the South-east coast of Inagua are several detached coral reefs about, and at some distance from, the S.E. point. On one of these H.M.S. *Statira* was lost; and on another, if not the same, the bark *Emerald*, Captain Nockells, struck, at 5 p.m., 11th June, 1834, on her passage from Jamaica to London. The bark was on it for two hours, while the small islet off the S.E. point bore West, distant 4 miles, and the nearest shore was 5 miles off. The depth of water was about 18 feet. The captain observes that, as broken reefs may extend a long way out, vessels in passing should not advance within 10 miles of the shore. The *Emerald* was so much damaged that it became necessary to abandon her; and on the next day, at 7 p.m., her crew were saved in a Spanish schooner, bound for Philadelphia, being then, with 9 ft. of water in her hold, in lat. 20° 36′, long. 73° 10′, 24 miles to the southward of Inagua. It is now marked by a lighthouse near the S.W. point, which shows a revolving light every minute at 120 ft., visible 17 miles.

12. SILVER KAY BANK.—It seems that the *Fletcher Reef*, said to have been discovered near the S.W. extremity of the Silver Kay Bank, in 1833, really exists on the S.W. part of that bank, the true form of which was, for the first time, ascertained by Captain Owen and assisting officers, as now exhibited on the charts. Its N.E. side is extremely dangerous, having a cluster of rocky heads, extending 18 miles, and even with the water. There are also detached patches on the North and north-western parts.

13.—The BAJO DE NAVIDAD has been described as a fine clear bank of an oval form. Its greatest length 22 miles North and South, and 11 in breadth; the least water on it 11 fathoms, which is on the S.E. edge. The general depths 16 and 17 fathoms, very even bottom, coral and sand; the water being of a darkish hue, the bank is not easily distinguished.

There is but little secular change in the VARIATIONS of the COMPASS hereabouts.

18.—CUBA, JAMAICA, ETC.

	LAT. N.	LONG. W	VAR. EAST, 1878-9.	AUTHORITIES.
SOUTH SIDE OF CUBA.	° ′ ″	° ′ ″	° ′	
Cape Maysi, Lighthouse [1]	20 15 10	74 10 24	2 20	Chiefly from the Surveys by the Spanish Navy, with partial surveys by Captain Richard Owen, R.N., and recent English Surveyors.
Port Guantanamo, E. head	19 55 0	75 16 0		
SANTIAGO DE CUBA, Blanca Battery .....[2]	20 0 19	75 50 22	2 50	
,, Morro Lighthouse.....	19 57 42	75 54 20	3 30	
Cape Cruz, Lighthouse	19 50 0	77 44 30		
Caballones Channel, Pilot Point	20 46 30	78 58 30		
Boca Grande Cay, West pt.	21 0 0	79 19 0		
River Guaurabo, Ciriales Point	21 46 0	80 2 0		
Port Xagua or Jagua, Lighthouse	22 1 0	80 30 0		
Pagua Bank, shoal part ..	20 37 0	80 35 0		
Xiedras Cay, Lighthouse ..	21 58 0	81 3 0		
Jardines Bank, East point	21 39 0	81 2 0		
Rosario Channel, South entrance	21 37 0	81 55 0		

CUBA, JAMAICA, ETC.—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Isle of Pines, Frances Point [3]	21 37 15	83 12 34		Chiefly from the Surveys by the Spanish Navy, with partial Surveys by Captain Richard Owen, R.N., and recent English Surveyors.
Isle of Pines, extreme South point	21 21 24	82 56 0	5 0	
San Felipe Cays, S.W. part	21 55 0	83 32 0		
Laguna de Cortes, small Cay at entrance	22 4 0	83 51 0		
NORTH COAST OF CUBA.				
Cape Antonio, extreme	21 51 30	84 58 4	5 35	
Colorados Reef, West end	22 9 0	84 48 0		
Jutias Cay, Lighthouse (proposed)	22 43 20	84 6 30		
Bahia Honda, Point Cerro del Morrillo	22 58 49	83 12 0		
HAVANA, Morro Lighthouse [4]	23 9 20	82 22 12	4 40	REMARKS.
„ Engineer's post under No. 4 fort	23 8 53	2 20 43		The greater part of the harbours are singularly formed, having a narrow entrance mostly bordered with a reef or shoal, but opening into a fine basin inward, which affords shelter from every wind. Of such are St. Iago, Guantanamo, Escondido, Baitiqueri, Mata, and Baracoa; but the entrance of the latter is bold-to; again, Iaco, Yaguaneque, Cebollas, Tanamo, Cabonico and Livisa, Nipe, Banes, Naranjo, Vita, Jururu, Del Padre, Malagueta, Manati, Nuevitas, Havana, Mariel, Bahia-Honda, and Jagua.
Peak of Matanzas, summit	23 1 54	81 45 0		
Cay Piedras, Lighthouse	23 14 42	81 8 17		
Bahia de Cadiz Cay, Lighthouse	23 13 0	80 30 0		
Paredon Grande Cay, Lighthouse	22 29 3	78 9 53	3 0	
Cay Confites, South point	22 11 14	77 40 5		
Cay Verde, N.W. end	22 8 45	77 38 15		
Maternillos Point, Lightho.	21 40 6	77 8 57		
Port Nuevitas, Lighthouse, Barlovento Point	21 37 30	77 5 16		
Port Padre, Point Guinchos	21 18 30	76 36 16		
Port Naranjo, East side of entrance	21 7 30	75 53 0		
Peak of Sama, summit (885 feet)	21 7 0	75 48 22		
Port Nipe, Roma Point	20 47 14	75 34 0		
Port Sama, East side of entrance	21 9 0	75 48 0		
Lucrecia Point, Lighthouse	21 4 38	75 37 55	2 30	
Port Cayo Moa, Carenero Point	20 41 41	74 53 0		
Port Baracoa, Lighthouse	20 21 0	74 28 30		
The GRAND CAYMAN:— S.W. Bay, Fort George	19 17 45	81 24 3		
JAMAICA, AND ISLES ADJACENT. [5]				
Navassa Island, North extreme	18 25 10	75 2 3	3 10	From the Surveys of Captain R. Owen R.N.. 1835, and more modern surveys of particular localities.
Morant Cays, N.E. Cay	17 26 30	75 58 20		
Formigas Bank, shoal spot	18 33 0	75 44 24		
MORANT POINT, Lightho.	17 55 5	76 11 50		

CUBA, JAMAICA, ETC.—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Port Morant, Bowden Pier	17 53 15	76 19 55		From the Surveys of Captain R. Owen, R.N., 1835, and more modern Surveys of particular localities.
Morant Town Church	17 52 55	76 25 30		
Lamottes Bank (4 fathoms)	17 50 10	76 30 30		
Cow Bay Point	17 52 20	76 37 5		
Plum Point Light.....	17 55 40	76 47 15		
PORT ROYAL, Ft. Charles, Flagstaff .....[6]	17 56 6	76 51 10		
KINGSTON, Fort Augusta Light	17 58 0	76 51 30		
„ St. Michael Ch. .	17 58 0	76 47 30		
Portland Bight, Pigeon Id., centre	17 47 40	77 5 0		
Portland Point	17 42 12	77 10 0		
Carlisle Bay, Pier	17 46 20	77 17 30		
Round Hill	17 51 0	77 23 0		
Alligator Reef, N.E. end..	17 49 0	77 32 20		
Pedro Bluff, S.W. extreme	17 51 12	77 45 12		
Black R. Anch., Church ..	18 1 0	77 52 10		
Savanna la Mer fort, ruin .	18 12 15	78 8 50		
Negril Bay, Wharf in South part	18 16 56	78 22 24	4 0	
St. Lucia, Fort	18 27 45	78 11 24		
Montego Bay, Fort	18 29 25	77 56 48		
Falmouth, Fort	18 30 34	77 40 24		
St. Anne Bay, Long Wharf	18 26 24	77 13 24		
Port Maria, N.W. Wharf..	18 23 0	76 54 54		
Port Antonio, Fort flagstaff	18 11 15	76 27 24		
Machioneal Harbour, South entrance point	18 2 50	76 17 35		
Red Cliffs	17 59 30	76 15 20		
PEDRO BANK, East end, Portland Rock .....[7]	17 8 0	77 27 0		
„ S.W. Breakers	16 48 0	78 13 0		
„ N.W. edge ..	17 36 0	78 52 0		
Baxo Nuevo, Sandy Cay [8]	15 53 0	78 39 4		
GRAND CAYMAN, Fort George, West end .. [9]	19 17 45	81 23 54		
Little Cayman, West point	19 39 10	80 7 54	4 30	
Cayman Brac, S.W. point .	19 40 35	79 54 59		
„ N.E. point .	19 44 30	79 43 53		
Pickle Bank, Centre.....	20 23 20	80 29 50		
SERRANILLA, S.W. Cay[10]	15 47 45	79 50 43		

NOTES.

1. CAPE MAYSI.—Captain Foster places Cape Maysi in 74° 5′ 18″, considering Chagres as 78° 57′ 19″. Captain Owen made it 74° 8′ 0″.

2. ST. IAGO DE CUBA.—Mr. Nicholls, Master of the *Shearwater* brig of war, in 1819, communicated the situation of the Morro Castle of St. Iago, from observations made in that ship, as follows:—Latitude observed, 19° 57′ 50″; longitude by lunars, 76° 2′ 45″; by chronometer, 76° 0′. The Spanish Chart of the harbour represents the Morro as in 76° 55′ 33″ W.

Telegraphic determination from Havana, by U.S. Hydrographic Office in 1875, places the Morro Lighthouse in long. 75° 52′ 6″ W.

3. Cape Antonio, Isle of Pines, &c.—On the 12th of August, 1817, Capt. Livingstone came to an anchor off Cape Antonio, in 7 fathoms; and by an excellent observation, found his latitude to be 21° 53′ 54″; this confirms that which has been given by the Spanish officers. The longitude is well established between 84° 57′ and 84° 58′. The Baron von Humboldt gives 84° 57′; Captain Owen, 84° 58′; the Spanish officers had previously given it as 84° 57′ 30″.

4. Havana and Lighthouse.—The longitudes in the western part of the Caribbean Sea depend upon the position of the Morro Lighthouse, Havana, given by Don José Joaquin de Ferrer, Astro, Soc. Mem. iv. 586; lon. 82° 22′ 12″ W.—Note: Telegraphic determination from Washington, U.S., by U.S. Hydrographic Office in 1875, places Morro Lighthouse in long. 82° 21′ 23″ W.

The position of the Engineer's post, near the steam wharf under fort No. 4, Havana Harbour, has been deduced from the Morro Lighthouse, and is here given as being convenient for rating chronometers, lat. 23° 8′ 53″ N., long. 82° 20′ 43″ W.

The position formerly given was lat. 23° 8′ 18′ N., long. 82° 22′ 4″ W. The longitude being the mean of twenty results from stars eclipsed by the moon, by Don Josef Joachim de Ferrer, 1809-10-11-12. This place, which is taken by Lieutenant Raper as a secondary meridian, is considered by him as in long. 82° 21′ 57″ W. The difference, 17″, between this and Mr. Purdy's position, as given in our previous editions, is but trifling, and the difference between Mr. Purdy's position in 1850 and that determined electrically from Washington in 1875, is but 17″, the latter position placing it in 82° 21′ 23″, or 27″ less than shown in the Tables.

5. JAMAICA in general.—"In his outline of Jamaica, 1821, Mr. De Mayne gives Morant, or the eastern point, in longitude 76° 12′, and South Negril, or the western point, in 78° 25′ W. Mr. Leard, in his survey of 1791, gave Morant Point in 79° 3′, and South Negril in 78° 33′; consequently he represented the island more than 15′ longer than it has since been exhibited.

6. Port Royal.—Telegraphic determination from Havana, by U.S. Hyd. Office in 1875, places the flagstaff at Port Royal in long. 76° 50′ 31″ W. The northern coast, it appears, was placed too far North from 1 to 2 miles.

7. Portland Rock.—The Portland Rock is a single kay, 15 to 20 feet above the sea, and covered with small bushes. It has been variously represented in from lat. 17° 7½′ to 17° 13′ and from long. 76° 32′ to 77° 31′. In Mr. De Mayne's Chart it appears in 17° 7½′ N., and 77° 29′ W. The position given in our Table cannot, we think, be far from the truth.

The officers of H.M.S. *Winchester*, in 1834, by numerous altitudes, &c., gained the latitude of the rock as 17° 7′ 25″, and long. 77° 27′ 4″.

8. Baxo Nuevo.—According to the Spanish officers, 1804, the extent of this shoal is about 7 miles from North to South, and 14 miles from East to West. All the eastern part is a reef, very steep-to, but on the West the depth diminishes gradually. At 1½ mile from the northern extremity is the Sandy Cay, given in the Table. The Baxo del Comboy, which is represented on the charts to the E.S.E. of the New Shoal, has been particularly searched for, but could not be found.

The shoal was examined by H.M. surveying ship *Thunder*, March, 1835; the small kay, given in the Table, was found to be 4 feet high, and a cable's length East and West, at 6 miles N.E. from the southern breakers. It presents no appearance of vegetation, and is composed of coarse coral, sand, and stones.

9. Grand Cayman.—The latitude of the S.W. kay of the Grand Cayman, as observed by Captain Livingstone, August 5th 1817, appeared to be 19° 14′, not 19° 11′, the parallel formerly assigned; the longitude was communicated to us by the late Captain Hurd, as

a determination to be relied on, and it appears to have been confirmed by Captain J. W. Monteith.

Don J. M. Herrera, of the Spanish Navy, places the East extreme of the Eastern Little Cayman (Cayman Brac) in lat. 19° 45′ 15″ N., long. 79° 46′ 24″ E., 1863.

The S.E. point, as communicated by Mr. Dunsterville, lies in lat. 19° 16′ N., and long. 81° 6′ 40″ W, The village on the West, formerly the *Hogsties*, is called *Georgetown*, but the most populous village is *Boddentown*, on the South.

10. SERRANILLA.—This bank, with its kays, formerly much misrepresented, lies between the parallels of 15° 35′ and 15° 55′ N., and the meridians of 79° 41′ and 80° 5′. On its eastern and southern sides are several kays and reefs. On the N.E. side is a detached patch of rocks, on which the sea constantly breaks; it is just awash, but, in fine weather, a rock will show about 2 feet out of the water. Between it and the main bank is a safe passage, of not less than 6 fathoms, bordering close to the western side of the reef. In clear weather, by day, all the rocky patches are easily avoided, but it is very dangerous to approach by night.

The VARIATIONS of the COMPASS are very slowly *decreasing*.

19.—STO. DOMINGO OR HAYTI, PORTO-RICO, AND THE VIRGIN ISLANDS.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
STO. DOMINGO.	° ′ ″	° ′ ″	° ′	
Isle of Mona, the Middle..	18 6 0	67 54 0	1 10	
Hobero, Right Bank	18 58 50	69 3 37		Sir Robert H. Schomburgk, F.R.G.S., 1852.
Punta Macao, ranchos	18 50 0	68 35 0		
Isle of Saona, W. point ..	18 14 0	68 53 30		
Quiabon. R. entrance	18 20 20	68 53 23		
Boca de la Romana	18 22 0	68 56 37		
Macoris	18 25 50	69 10 25		
Isles of Santa Catalina, W. point	18 19 0	69 0 0		
CITY OF SANTO DOMINGO, Cathedral, W. portal [1]	18 28 17	69 52 26	1 40	
Neiva Bay, River entrance	18 22 10	71 0 0		Captain Richard Owen, R.N., and Edward Dunsterville, Esq., R.N., 1826, 27, 32.
Alta-Vela, or the High Sail .....[2]	18 29 30	71 38 0		
Cape Jacquemel, or Jacmel	18 11 20	72 35 15	2 38	
Pta. Ajugas, or False Cape	17 47 0	71 41 0		
Frayle Rocks, S. end	17 36 0	71 41 0		
Aquin Bay, Grosse Kay, centre	18 13 30	73 27 0		
St. Louis, the Old Fort ..	18 14 27	73 35 30		
Aux Cayes, the Town	18 11 10	73 46 0		
Isle à Vache, E. Point	18 4 0	73 36 30		
Point Abacou.....	18 2 0	73 50 0		
Point à Gravois.....	18 2 20	73 58 30		
Cape TIBURON, extremity .	18 22 0	74 28 32	2 50	
Irois Bay, House on the Beach	18 23 48	74 29 33		
Isle of Navaza, middle	18 25 45	75 3 0		
Cape Dame Marie, or Donna Maria	18 37 30	74 27 31		Staff Comm. Kiddle, R.N., 1873.
Jérémie Bay, Wharf.....	18 38 0	74 5 45		

STO. DOMINGO, PORTO RICO, &c.—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Miragoane Harbour, Town	18 28 0	73 4 30		Captain R. Owen, R.N., and Commander E. Dunsterville, R.N.
Pirogues, on the Rochelois Reef	18 38 20	73 14 0		
Hummock of Petit Gonave	18 26 51	72 45 39		
Isle of Gonave, West Point	18 55 26	73 18 30		
PORT AU PRINCE, Fort Bigithon	18 32 12	72 22 25	2 10	
Arcadins, northernmost	18 48 0	72 38 0		
St. Marc, or St. Mark's Pt.	19 2 10	72 51 0		
Port Piment	19 37 0	73 1 0		
St. Nicholas Mole, Fort George	19 49 30	73 27 33		
Port à l'Ecu	19 55 10	73 5 30		
Port Paix, Carenge Point	19 58 0	72 48 45		
Tortue or Tortuga Isle, W. Point	20 8 20	72 57 30		
„ East Point	20 1 0	72 36 0		
CITY OF CAPE HAYTIEN, Watering Place	19 46 40	72 10 42	1 50	
Manzanillo Bay, Manzanillo Point	19 45 34	71 47 20		
The Grange Point	19 54 45	71 40 0		U.S.S. *Congress*, 1871.
Point Isabelica	19 58 40	71 6 30		
Isabella Bay, Islet	19 53 50	71 4 7		
Port Plata, E. Point	19 49 0	70 42 3		
Old Cape Français	19 40 30	69 55 0		
Cape Cabron	19 21 30	69 14 13		
Cape Samana	19 15 40	69 6 15		The observations of the Spanish Officers, particularly those of Capts. Don Cosmé de Churruca, Francisco Fidalgo, Juan Romero, &c.
Cape Raphael	19 2 0	68 53 30		
Cape Engaño, extreme	18 35 51	68 20 40	1 10	
Point Espada	18 19 43	68 28 16		
ISLAND OF PORTO-RICO.				
Cape St. Juan, or N.E. Pt.	18 24 30	65 37 0	0 35	
MORRO CASTLE OF ST. JUAN [3]	18 29 0	66 7 0		
Point Bruguen, or N.W. Point	18 27 18	67 11 0	0 50	
Isle Desecho or Zacheo	18 23 48	67 30 40		
Aguadilla Town [4]	18 25 40	67 10 17		
Mayaguez Bay, Light	18 13 0	67 8 0		
Aguila Point, S.W. pt.	17 58 0	67 15 0		
Port Ponce Custom House	17 58 51	66 39 30		Lieut. G. H. Stoate, R.N., 1875.
Puerto Guanica, E. Point	17 57 44	66 58 0		
Caxa de Muertos, or Coffin, S.W. Point	17 52 30	66 35 0		
The VIRGIN ISLANDS.				
Anegada, W. Point	18 50 0	64 25 12	0 5	The Survey by Lieut. G. B. Lawrence, R.N., 1848.
„ East Point [5]	18 43 48	64 16 20		
Soldier, or North Point	18 45 15	64 20 20		
„ Horse-shoe Reef, S.E. end	18 36 30	64 11 0		

THE VIRGIN ISLANDS, &c.—CONTINUED.

	LAT N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Herman Reef, 16 ft., South Point	18 33 30	64 14 0		The Survey by Lieut. G. B. Lawrence, R.N., 1848.
Virgin Gorda, Pajaros, or East Point	18 30 42	64 19 9		
Ginger Isle, centre	18 23 45	64 28 41		
Tortola, Road Town. Fort Burt	18 25 3	64 37 0		
St. John's, S.E. Point	18 19 0	64 44 20		
Sta. Monica Rock (9 feet)	18 19 0	64 39 30		
ST. THOMAS HARBOUR, Ft. Christian [6]	18 20 27	64 55 40	0 2	
The Bergantin or Carvel	18 18 0	65 7 0		
ST. CROIX or SANTA CRUZ: Eastern extremity of the Island [7]	17 45 30	64 34 0		A communication made to Mr. Dunsterville by Sir A. Lang, of St. Croix, Jan. 21, 1832.
The Lang Observatory [8]	17 44 32	64 41 6		
Harbour of Christianstæd, Flagstaff of the Outer Point Battery, called *Fort Louisa Augusta* [9]	17 45 28	64 41 42		The general height of the tops of the hills in St. Croix is from 800 to 850 English feet above the level of the sea, excepting toward the northern side of the north-western district of the island, where they ascend higher, and the highest of which called *Mount Eagle*, is 1,156 feet above the level of the sea. Its summit is in lat. 17° 45′ 52″, and long. 64° 48′ 31″.
Fort Christianswærn, in the town of Christianstæd, Flagstaff	17 44 59	64 41 58	0 25	
Salt River Point [10]	17 47 12	64 44 45		
Hams or N.W. Bluff [11]	17 46 24	64 52 3		
Fort at Frederickstæd or W. end, Flagstaff [12]	17 43 10	64 52 48		
Sandy Point, the south-west extremity of the island [13]	17 40 30	64 53 48		Along the greater part of the South side of the island a ledge of reefs lines the coast, at a distance from shore, in some places, of nearly 2 miles. There are few channels through these reefs, practicable for small vessels only.
Buck Isle, East extremity [14]	17 47 18	64 36 40		
,, North-West extremity	17 47 30	64 37 37		
Its summit, about 350 feet above the level of the sea	17 47 15	64 37 3		

NOTES.

1. SANTO DOMINGO.—We previously gave the longitude of the City as 69° 58′, on the authority of the Spanish officers, Capts. Don L. Argedas and J. A. Sartorio, who observed an eclipse here in 1780, with a subsequent correction of 1½′. This result was considered by the talented and energetic Sir Robert H. Schomburgk, F.R.G.S., on his appointment to the Dominican consulate in 1849, to be too far West, and he accordingly made many observations, and collected others of authenticity, and placed it as stated in the Table.

2. ALTA VELA, or the High Sail.—This is a high rocky islet, which serves as a general point of departure to all ships bound from the eastward to Jamaica, &c. It is peaked, and appears to the northward, at a distance, like a dome, emerging above a mist or fog.

On the authority of the respected and scientific Admiral Espiñosa, of the Spanish Navy, we formerly gave Alta Vela in long. 71° 22′ W., instead of a more westerly position, which had previously been assigned; but it is now fully proved that this is

wrong, and that the true longitude is about 71° 38′. Mr. Dunsterville, from the mean of observations in 1826 and 1829, made it 71° 39′ 25″ W. Captain R. Owen made the summit in 71° 39′ 44″ W.

3. Morro of St. Juan.—The Harbour of St. Juan was surveyed by Don Cosme de Churruca, in 1794. The position given in the Table is from the statement of Don Josef Cerquero, director of the Royal Observatory in the Isle of Leon, near Cadiz. The longitude was considered as one of the best established in America.

4. Aguadilla.—The situation of Aguadilla, as given by the Spanish Officers, is 18° 25′ 53″ N., and 67° 6′ 20″ W. Admiral Mackellar gave it as 18° 24′ 57″ N., and 76° 8′ 25″ W.

5. Anegada, with its reef, were surveyed by Mr. (afterwards Sir) Robert Herman Schomburgk, the distinguished traveller, in 1832. We formerly enumerated, in the description of the Caribbean Isles, the number of wrecks that lay upon the reefs in 1811; and Sir R. Schomburgk has noticed that, between 1811 and 1832, twenty-one American, seventeen West-Indian, fifteen Spanish, nine British, two French, two Swedish, and one Portuguese, were wrecked here; and this is attributed chiefly to the insensible operation of the currents.

6. St. Thomas's.—With the position of Fort Christian, as given in the Table, from a Danish Survey, compare the communication of Captain J. W. Monteath, "Colombian Navigator," vol. iii., note 3, p. xx. But upon this point we received the following communication from Major Sir Andrew Lang:—"The bearings of the flagstaff of *Cowel's Battery*, from my observatory (see note 8, hereafter), N. 21° 54′ 27″ W., from the true meridian, were determined by myself with a Troughton's altitude, azimuth, and transit circle. Notwithstanding the distance (37½ miles), the flagstaff was distinctly seen with the telescope of the circle, and intersected with the vertical wire. Considering the latitude of the flagstaff, 18° 19′ 32″ N., which must be near it, then its longitude is as stated 64° 55′ 45″ W., as deduced from my position; but I now strongly suspect that it is a little more to the North, say in 18° 19′ 45″; if so, its longitude, as deduced from my station, will be 64° 55′ 50″ W., and the latitude and longitude of Fort Christian would, on the same data, be lat. 18° 20′ 39″ N., long. 64″ 55′ 39″ W. (This is now confirmed.) Fort Cowell is on the very top of an eminence (275 ft. above the level of the sea) which rises at the southern extremity of a tongue of land, which forms the western side of the entrance, and also the western shore of St. Thomas's Harbour."—Signed *Andrew Lang.*

7. St. CROIX.—Fully 9 nautic miles from the eastern extremity, N.E. by E. ½ E. (*true*), and about 11 miles E. by N. from the East point of Buck Island, commences the eastern extremity of an extensive bank or shoal, the northern limit of which rounds off from thence to the N.W., and soon after stretches westerly, inclining to the South of a westerly direction toward Buck Island shoals and reefs, with which it may be considered as connected. The northern edge of the shoal is a coral ledge, several miles in extent, on which 3½ fathoms of water is the least depth yet found; the more common depths being 6, 6½, and 7 fathoms. The sea has been observed to break on the whole line of the northern edge, and to the very extremity of the bank, in an alarming manner, during a northerly ground swell in the winter months.

8. Observatory of Sir Andrew Lang.—"The height of the observatory above the sea is 440 English feet. The latitude is true to within one second. The longitude is the result, I may say, of the labour of years, and the present assumption of 64° 41′ 0″ in arc, or 4ʰ 18′ 44″ in time, West from Greenwich, I consider to be determined with almost such absolute certainty, that I do not think the error in the determination can exceed four seconds in time, or one minute in arc, and I trust less. On that datum the longitudes of the other stations are accurately determined. All the latitudes are certain to one or two seconds."—*Andrew Lang.*

[*From the observatory communication by signal will be attended to. The observatory is*

situated about 1 *mile to the E.S.E. of the town of Christianstæd. In clear weather the shoals are distinctly seen.—E. Dunsterville.*]

9. CHRISTIANSTÆD.—Nearly 1 mile due North of the entrance of the harbour of Christianstæd is the western extremity of a reef called the Scotch Reef, which stretches from thence, with its shoals, fully 1½ mile to the E.N.E., rendering the approach to the harbour very dangerous to strangers.

10. SALT RIVER.—Salt River Point is comparatively a low point, and one of the most northerly in the island. About one-fourth of a mile to the North of it is a dangerous sunken rock, called the White Horse, on which the sea generally breaks.

11. HAMS BLUFF, along its northern part, is bold to.

12. FREDERICKSTÆD, or West-end Bay, is an extensive and beautiful bay, affording excellent and smooth anchorage, except where the wind has westing; but like all anchorages of that open kind, it then becomes dangerous.

13. SANDY POINT.—To the South of this low and deceiving point, at nearly a mile, there extends a dangerous reef, to which a good berth should always be given.

14. BUCK ISLAND.—This island, except on its southern side, is surrounded with dangerous reefs and shoals, extending fully 1 mile to the W.N.W. of the N.W. point of the island; fully two miles to the eastward of its eastern extremity; and about 1 mile to the North of the island; forming, in the intervening bearings, a circuitous connection of the greatest dangers, which all prudent persons will avoid approaching.

The VARIATIONS OF THE COMPASS are subject to very little alteration in the East part of the section. They are *decreasing* at an annual rate of about 2′ in the West portion.

20.—THE CARIBBEE AND LEEWARD ISLANDS.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
CARRIBBEE ISLANDS. [1]				
Sombrero Lighthouse..[2]	18° 35′ 45″	63° 27′ 45″	No° Var.	Captain E. Barnett, R.N., Lieut. E. Lawrence, R.N., Mr. Parsons, R.N., &c.
Dog Isle, landing on S. side	18 16 15	63 16 10		
Anguilla, Custom House on North side	18 13 0	63 4 40		
ST. MARTIN'S; Philipsburgh, Fort William	18 1 25	63 4 24		
„ West Point	18 3 25	63 10 0		
Saba, the middle	17 38 0	63 14 0		
St. Bartholomew, Fort Gustavia	17 53 50	62 51 30		
St. Eustatius, Orange Town	17 29 0	62 59 0		
ST. CHRISTOPHER'S, Basse Terre..[3]	17 18 0	62 42 50	0 15	
Nevis, Charlestown	17 8 50	62 34 50		
Redonda, the Pinnacle, 600 feet	16 56 0	63 19 0		
Montserrat; Plymouth, on South side wharf	16 42 12	62 13 0		
Antigua; St. John's Road, Fort James..[4]	17 6 40	61 51 21		
Fort Byham, on N.E. side	17 7 20	61 46 17		
Dockyard Flagstaff, English Harbour	17 0 0	61 45 42		
Desirade or Deseada, N.E. Point..[5]	16 22 0	60 58 0		

THE CARIBBEE AND LEEWARD ISLANDS—Continued.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
GUADALOUPE, Basse-Terre Mole Head Light....[6]	16 0 15	61 44 50	0 15	Captain E. Barnett, R.N., Lieut. E. Lawrence, R.N., Mr. Parsons, R.N., &c.
St. Anne anch. approximate	16 14 40	61 19 40		
Port du Moule	16 21 0	61 18 0		
Pointe à Pitre, Jarry Mill	16 13 56	61 32 34		
Marie-Galante Grand Bourg Light	15 54 0	61 17 0		
The Saintes; St. Paul, Bolt Head, S.W. Point	15 51 20	61 37 30		
Aves Islet....[7]	15 42 0	62 37 45		
DOMINICA, Rd. of Roseau				
Fort Young....[8]	15 17 27	61 23 32		
Cape Melville, N.W. Pt.	15 38 20	61 28 0		
Prince Rupert Bay, Catholic Church	15 34 37	61 27 54		
MARTINIQUE, Ft. Royal [9]	14 36 7	61 4 38	0 25	
St. Lucia, Pt. Moulacique or South Point	13 43 0	60 57 0		
Port Castries Wharf	14 1 12	61 0 0		
ST. VINCENT, Kingston Ch.	13 9 0	61 13 24		
GRENADINES Bequia, Admiralty Bay, Church	13 0 25	61 13 53		
BARBADOS; Bridgetown, Fort Beckwith....[10]	13 4 53	59 36 18		Harris and Stanley, 1869.
Grenada, Fort St. George [11]	12 3 2	61 44 55		
TOBAGO, N.E. Point..[12]	11 20 59	60 31 6	1 5	Mr. J. Parsons, R.N., 1864-5.
Scarborough Landing Wharf	11 10 55	60 43 35		
———, Crown Pt., S.W. end	11 8 35	60 49 55		
TRINIDAD:—[13]				
Point Galera, N.E. Pt.	10 50 2	60 54 10		Commr. W. Chimmo, R.N., 1866-8.
Point Galeota, S.E. Pt.	10 8 10	60 59 15		
Saparia Hill, 400 feet centre	10 5 30	61 28 0		
Icacos, or S.W. point	10 3 20	61 55 45		
San Fernando Pier Head	10 16 59	61 28 10		
Cipero River, entr.	10 15 50	61 28 30		
Port Spain, Battery flagstaff	10 38 40	61 30 36	1 25	
Entrada, or N.W. point	10 42 22	61 40 15		
Goose Island, E. end	10 38 20	61 51 20		
Testigos, Centre	11 23 15	63 5 50		
MARGARITA:—				
Pampatar Castle	10 59 15	63 48 30	1 50	The Survey of the Coasts of Venezuela, &c., by Don Joaquin Francisco Fidalgo, and other Spanish Officers. Published by the *Direccion Hidrografico*, at Madrid, in 1816 and 1817. The longitudes adjusted.
Margarita, North Point	11 10 30	63 53 30		
Pta. de Arenas, or Sandy Point	10 59 0	64 24 30		
Blanquilla, North Point	11 54 30	64 36 30		
Tortuga, East Point	10 54 45	65 12 0		
Orchilla, N.E. Breakers	11 52 45	66 3 0		
Shoal of Two Fathoms	12 9 15	66 6 20		

THE CARIBBEE AND LEEWARD ISLANDS—CONTINUED.

	LAT. N.	LONG. W.	VAR. WEST, 1878 9	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	Spanish Surveys, &c.
El Roque Lighthouse	11 58 15	66 38 30		
Ilas de Aves (*Birds' Is.*):—				
Windward Isle	11 57 30	67 24 20	2 30	
Leeward Isle	11 59 30	67 40 10		
Buen-Ayre, N.E. point....	12 14 0	68 15 0		
„ S. Point Light	12 2 30	68 17 20		
CURAÇAO, North Point	12 24 0	69 10 0	2 50	
Bay of St. Anna, entrance				
Rif Fort	12 6 10	68 55 10		
Little Curaçao, N. end	12 0 0	68 40 0		
Oruba, S.E. Point	12 23 45	69 55 0		

NOTES.

1. WINDWARD AND LEEWARD ISLANDS.—Under the denomination of *Windward Islands*, the navigators of France and Spain include the whole range from the Virgins to Trinidad; and, under that of Leeward Islands, the range which exists between Trinidad and the Gulf of Maracaybo. This distinction is natural and proper, and we have adopted it, in preference to the former distinction in the English charts, which includes, under the name of Leeward Islands, those from Porto Rico to Dominica; and, under that of Windward Island, those from Martinique to Tobago.

The observations of the Spanish officers for determining the respective situations of the Caribbee Islands were very numerous and important, and our late charts have been regulated chiefly thereby. Some later corrections have, however, been made, particularly in the northern part of the range, and in the Virgin Isles.

2. SOMBRERO.—This solitary islet is a flat and rocky eminence, 2¼ miles in length, N.N.E. and S.S.W., without any hummock, having neither quadruped nor vegetable upon it, excepting grass, and that generally dry, with a few weeds, &c. It is even destitute of water. It has been surveyed by our Admiralty.

3. ST. CHRISTOPHER'S—In January, 1782, the Marquis de Chabert took nine meridian altiudes, whence he concluded the latitude to be nearly as in the Table. The longitude by his marine clocks, previously examined at Martinique, appeared as 62° 52′ 30″. Mr. Zahrtmann made the difference of longitude between it and St. Thomas's 2° 13′ 27″, or in 62° 42′ 13″, nearly as in the Table.

4. ANTIGUA.—Our former position was a close approximation to that of Captain E. Barnett, R.N., whose fine survey of 1848 gives a perfect picture of the island.

5. DESIRADE.—From observations made by the Chev. de Borda, he computed the latitude of the N.E. point as 16° 20′ 30″.

Captain Monteith, in lat. 16° 58′, by three observations. Longitude of a ship by chronometer, 61° 9′ 45″; by lunars, 61° 14′ 38″; mean, 61° 12′ 12″. Bearing of Desirade S. 5° E., distance 36 miles, which gives 3′ of departure—long. 3′ 5″. Hence longitude of the centre of Desirade, 61° 9′ 7″ about 8′ too far West.

6. GUADALOUPE.—The latitude of Basse-Terre has been confirmed from observations of M. de Verdun, &c. The longitude (assuming Fort Royal, Martinique, as in 61° 9′) appeared to be 61° 48′ 15″; but if Martinique is 4′ 50″ East of this, it will place Guadaloupe in 61° 43′ 25″. The difference of longitude between Guadaloupe and St. Thomas (64° 55′ 40″)

was found by Mr. Zahrtmann to be 3° 10′ 2″, and another measurement makes it 40° 35′ West of Guadaloupe; these combined will place it in 61° 44′ 16″, nearly as in the Table.

A lighthouse on *Terre de Bas Islet* (or Petite Terre) at the eastern extremity of the Island of Guadaloupe, shows a fixed light at 108 feet above high water, and is visible in all directions for 5 leagues. A rock, called the *Baleine du Sud*, bears S. 19° W., 2,920 feet from the lighthouse. Ships coming from the eastward will find from 13 to 20 fathoms water, at the distance of 2 miles North or South of the light, and should not approach it nearer. M. Tondu, in 1784, concluded the longitude, by three immersions and two emersions of the first satellite of Jupiter, to be 61° 48′. The latitude of Pointe des Chateaux, the eastern point, was observed by Mr. de Borda as 16° 12′ 30″

St. Anne anchorage was surveyed in 1872 by Messrs. Ploix and Caspari. The observation for the jarry mill at Pointe a Pitre is by Lieutenant Boucarut, F.I.N.

7. Aves Islet.—The position of this small kay was ascertained by Lieutenant Lawrance in 1850. It has been lately much visited for a stratum of guano which covered it, and which was the subject of some dispute. This is probably now removed, and leaves the place but a bare reef.

8. Roseau.—The latitude of this place, according to the result of observations by Messrs. Verdun, &c., is 15° 18′ 23″ French officers have given the longitude to the westward of that shown in the Table, but the latter is probably correct.

9. Martinique.—The latitude accords with that resulting from the observations of Messrs. Verdun, Borda, &c., who concluded the longitude as 61° 0′. Capt. Dunsterville gives the longitude of the Diamond Rock as 61° 6′.

In the Survey of Martinique, executed by order of the French Government in 1824 and 1825, the longitude of the flagstaff of Fort St. Louis, on which all the other longitudes depend, was assumed by M. Monnier as 61° 1′ 25″ This was arrived at by measurements from Rio Janeiro, &c., and is 3′ less than that now given.

The longitude in the Table is assumed from a mean of chronometric measurements by M. Zahrtmann and M. Lartique, between this and the observatories of St. Croix and St. Thomas, positions which may be considered as finally determined. These differences of longitude are taken as 3° 36′ 58′ East of St. Croix, and 3° 51′ 7″ from St. Thomas.

10. Barbados.—The late Dr. Nevil Maskelyne communicated the latitude of St. Michael's Church, in Bridgetown, as 13° 5′ 30″. The longitude has since been given as 59° 53′ 40″ and 59° 41′ 15″. From four separate measurements of the meridional difference between Port Royal and Barbados, it may be taken as 17° 30′ 10″, which will give 59° 37′ 35″ as the longitude of Barbados.

In 1850, Lieutenant G. B. Lawrence, by a careful measurement from St. Thomas with 17 chronometers, made Fort Beckwith, as in the Table, in longitude 59° 36′ 45·6″ W.

11. Grenada.—In 1779, M. de Chabert concluded the latitude of Fort St. George as 12° 2′ 54″, and its longitude 42½ West of Fort Royal, Martinique. This varies only 8′ from the statement in the Table. Captain G. Daniell, of H.M.S. *Victor*, in 1833, made the longitude 61° 48′ 90″. It was surveyed by Mr. James Young.

12. Tobago.—This island was very doubtfully placed on the charts previous to the survey by Mr. J. Parsons, R.N., assisted by Messrs. J. P. Dillon and W. B. Calver, in 1864-5. The positions given by these officers are those stated in the Table.

From the *lighthouse* on Bacolet Point, at the Port of *Scarborough*, the Minster Rock bears E.S.E., distant 1½ mile.

13. Port Spain in Trinidad.—Capt. Foster (vol. ii. page 249) made Fort St. Davids at Port Spain, 0h 52′ 0s·8 West of Para, which we have placed in 48° 30′ 12″ (S. Atlantic Mem., page 10), therefore it will make it in 61° 30′ 24″. M. Zahrtmann stated it to be 3° 10′ 12″ East of St. Croix—61° 30′ 48″; Captain Owen makes it 15° 19′ 0″ East of Port Royal, or 61° 31′ 45″, which is adopted by Lieutenant Raper; this is 2′ 30′ West of the position quoted in the former edition. The longitude, according to Lieutenant Lawrence, is

61° 31′ 0″ and these accord very closely with the position assigned to it by Capt. Chimmo as given in the Table.

Captain (now General Sir Edward) Sabine, R.A., has, from a great number of observations, given the position of Protestant Church in Port Spain, as 10° 38′ 56″ N., and 61° 35′ 0″ W. This beautiful church is said by Captain S. to be one of the many improvements and decorations for which Port Spain is indebted to its late governor, Sir Ralph Woodford, and which have rendered it one of the handsomest towns in the British colonies.

These *Easterly* VARIATIONS OF THE COMPASS are slowly *decreasing* in the West part of this section, but increasing at an annual rate of about 3′ in the East portion.

21.—THE COASTS OF GUIANA, ETC., TO THE MEXICAN SEA, INCLUSIVE.

	LAT. N.	LONG. W.	VAR. WEST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
CAPE NORTH, extreme....	1 42 0	49 48 0	0 45	M. Montravel, Sir R. Schomburgk, and others.
Mount Mayé, summit	2 49 30	50 52 21		
Cape Cachipour, extreme..	3 46 0	51 2 0		
Mount d'Argent, summit..	4 22 15	51 37 51		
Grand Connétable, centre	4 49 50	51 53 6		
CAYENNE, fort .....[1]	4 56 10	52 18 40	0 0	
Salut Isles, North extreme	5 16 50	52 32 51	EAST.	
Mont Diable, summit	5 10 30	52 51 55		
River Maroni, Française Point.....[2]	5 42 10	53 56 30		
„ West point of entrance.....	5 44 0	53 57 0		
Post Orange, village.....	5 53 50	54 33 30		
Surinam, beacon on Bram Point	5 56 0	55 4 0	1 0	
PARAMARIBO, Church	5 44 20	55 13 15		
Saramacca River, E. point of entrance.....	5 53 0	95 57 0		
Corentyn River, Nickerie battery	5 57 30	56 52 54		
Berbicé River, lightvessel	6 19 18	57 22 30		
DEMERARA, lighthouse * ..	6 49 20	58 11 30	1 10	
Mocomoco Point, extreme	8 39 25	60 10 15		
Barima Point, extreme....	8 37 0	60 23 0		
Ciudad Bolivar, market-place point	8 8 52	63 32 58		
TRINIDAD. *See page* 83.				
Chute d'Eau Island, centre	10 46 0	61 30 45		The Spanish Surveys of the Coasts of Venezuela, &c., by Don Joaquin Francisco Fidalgo, and other Spanish Officers. Published by the *Direcion Hidrographico*, at Madrid, in 1816 and 1817.
Chacachacare Island, rocks off S.W. point	10 40 3	61 45 54		
Pato Island, East point ..	10 38 15	61 51 18		
VENEZUELA. [3]				
Peña Point, extreme	10 43 48	61 50 50		
Testigos Island, N.W. extr.	11 23 45	63 9 0	1 40	

* These positions may be considered as standard points.

THE COASTS OF VENEZUELA, &c.—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Cape Tres Puntas, extreme	10 45 0	62 41 55		Spanish Surveys, &c.
Puerto Santo Islet, centre	10 43 0	63 10 55		
Carupano Lighthouse	10 39 30	63 15 0		
Esmeralda Islet, centre....	10 40 0	63 31 55		
Morro de Chacopata, extr.	10 42 0	63 50 25		
Escarseo Point, extreme ..	10 40 0	64 17 55		
Margarita Island, Ballena Point (see page 83)	10 59 0	64 47 55	1 50	NOTE.— Vessels should proceed with great caution between Margarita Island and the main. At night, anchorage will be found under Coche Island.
„ Arenas Point, W. extreme	10 58 30	64 25 0		
Sola Island, centre	11 19 0	63 36 0		
Cumano, Fort Boca	10 28 0	64 12 55		
BARCELONA Morro, hill ..	10 13 30	64 44 0		
Cape Codera, Morro	10 35 0	66 6 15		
TORTUGA ISLAND, Oriental Point	10 55 0	65 12 35		
Centinella Islet, centre	10 49 30	66 9 25		
La Guayra, La Trinchera Bastion	10 37 0	66 56 55		
La Silla de Caracas, summit (8,500 feet).....	10 32 30	66 50 55		
Puerto Cabello, St. Philip's Castle	10 29 30	68 0 25		
Turcacas Island, Ore House	10 47 0	68 19 55		
St. Juan Bay, Cay	11 10 0	68 27 55		
Cape San Roman, extreme	12 11 0	70 4 55		
Maracaybo Bar, Zapara Castle	11 1 0	71 40 0	3 50	
Espada Point, extreme....	12 4 0	71 7 55		
Los Monges, North islet ..	12 29 15	70 57 0		
ORCHILA ISLAND, W. point, rock.....	11 49 0	66 15 55		
LOS ROQUES, Port el Roque, Pirate Cay	11 57 0	66 38 55		
Aves Islands, West group, West extreme	12 0 0	67 42 25	2 20	
BUEN AYRE ISLAND, light-house	12 2 12	68 17 25		
Little Curaçao, lighthouse	11 58 0	68 38 40		
Curaçao Island, North point	12 21 0	69 11 10	2 50	
., Rif Fort, lighthouse	12 6 10	68 55 10		
ORUBA ISLAND, N. point..	12 36 0	70 7 55		
NEW GRANADA.				
Gallinas Point, extreme ..	12 25 0	71 44 25	3 20	
Bahia Honda, East point..	12 20 0	71 45 55		
Cape Vela, islet.....	12 10 15	72 12 55		
La Hacha, church.....	11 33 0	72 54 35		REMARKS.
Morro Hermosa.....	10 58 25	75 1 0		* The MORRO HERMOSA is a hill which constitutes a useful landfall westward of the Magdalena.
Santa Marta, cathedral ..	11 15 0	74 12 5	4 20	
Tribune Shoal	12 11 0	74 26 0		
CARTAGENA, Fort Pastelillo*	10 24 57	75 33 18	5 0	

* These positions may be considered as standard points.

THE COASTS OF NEW GRANADA, &c.—Continued.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
CARTAGENA, Baru Id; Fort San José	10 18 58	75 35 19		Spanish Surveys, &c.
Port Cispata, Zapote Point	9 24 0	75 48 0		
Fuerte Island, North extr.	9 24 0	76 10 45		
Caribana Point, extreme	8 37 30	76 52 55		
Cape Tiburon, extreme	8 41 30	77 21 30	5 30	
Port Carreto, peak	8 47 0	77 38 0		
Caledonia Harbour, Scorpion Cay	8 54 52	77 42 25		
Manzanillo Point, extreme	9 39 0	79 31 30		
PORTO BELLO, Fort St. Jeronymo	9 32 30	79 38 30	6 0	
Toro Point, extreme	9 23 0	79 56 0		REMARKS.
CHAGRES, flagstaff*	9 19 39	79 59 33	6 10	
Escudo de Veragua, West point of island	9 6 30	81 34 30		The whole of the coasts of the Bay of Honduras, from Cape Gracias a Dios to Cape Catoche, including the Isles and Shoals between the Pedro Bank and Costa Rica, have been surveyed under the able direction of Capt. Owen, Lieut. (after Capt.) Bird Allen, Lieut. (after Adm.) Edw. Barnett, Lieut. J. Cannon, and other skilful officers of the British Navy. These important surveys were the means of correcting enormous erors in the representation of the Gulf of Honduras, and they have also given a true representation of the Rio and Golfo Dulce, the coasts of which were never before explored.
Valiente Peak, summit (722 feet)	9 10 30	81 55 35		
Cobbler Rock, centre	9 14 30	82 8 24		
Shepherd Harbour, hut on summit	9 14 22	82 21 7		
Columbus Island, Lime pt.	9 24 47	82 21 4		
Tirby Point, extreme	9 25 45	82 22 20		
COSTA RICA AND MOSQUITO.				
Carreta Point, extreme	9 38 30	82 39 40	6 40	
Blanco Peak, sum. (11,740 feet)	9 16 30	83 4 0		
Blanca Point, Grape Cay	10 0 0	83 2 30		
Mount Cartago, pk. (11,100 feet)	10 1 30	83 48 0		
SAN JUAN DE NICARAGUA or Greytown, Arenas Pt.	10 56 45	83 43 14	6 40	
Port Limon, landing-place	10 0 0	83 3 13		U.S.S. *Kansas*, 1872.
Blewfield, Schooner Point	11 59 0	83 42 30	6 39	Owen.
Cookra Hill, summit	12 15 30	83 46 30		
Pearl Kay Lagoon, Mosquito Point	12 20 39	83 37 46		Barnett.
Pearl Kays, Columbilla Kay	12 22 35	83 23 44		
Great Corn Island, Wells North of Quin Bluff*	12 9 17	83 4 9		Owen.
Little Corn Island, Gun Pt.	12 17 30	82 59 9		
Brangman's Bluff, extreme	14 3 0	83 22 0		
Mosquito Kays, South end	14 21 12	82 46 30		
CAPE GRACIAS A DIOS, ext.	14 59 0	83 11 0		
Half-moon Kay, centre	15 8 50	82 42 42	6 5	
Gorda Bank, Gorda Kay	15 52 0	82 24 0		
Farrall Rock, centre	15 51 0	82 18 40		
Caxones or Hobbies, Great Hobby	16 3 30	83 8 51		
„ West end	16 6 0	83 19 0		

* These positions may be considered as standard points.

THE COASTS OF COSTA RICA, HONDURAS, ETC.—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878-9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Carataska Lagoon, E. side of entrance	15 23 40	83 43 9		Owen.
BAJO NUEVO, N.E. part of lee reef, sand-bank	15 53 0	78 38 33		
RONCADOR KAY, S. pt.	13 34 30	80 5 54		
ALBUQUERQUE BANK, S Kay	12 10 0	81 50 42		
COURTOWN KAYS, Middle Kay	12 24 0	81 29 9		
ST. ANDREW'S ID., S.W. cove, Entrance Island	12 31 40	81 44 14		
OLD PROVIDENCE, Isabel House*	13 22 54	81 22 39	6 10	
QUITO SUENO BANK, Spit at N.W. end	14 30 0	81 7 54		
„ S. ext. of reef	14 8 0	81 8 54		
SERRANA BANK, S. channel, Little Kay	14 21 30	80 15 30		Barnett.
SERRANILLA BANK, Beacon Kay	15 47 45	79 51 27		Owen.
ROSALIND BANK, N.W. ext.	16 54 0	80 52 0		
SWAN ISLANDS, West one. N.W. point	17 24 30	83 57 1	5 50	
HONDURAS AND OFF-LYING ISLANDS.				
River Patook, E. side of ent.	15 48 50	84 17 44	6 10	
Bonacca Id., S. side, Kay next eastward of Half-moon Kay	16 26 45	85 52 45		
Rattan, Port Royal, N.W. point of George Kay	16 23 45	86 19 14		
„ Coxen Kay, centre	16 18 0	86 35 0		
Hog Isles, W., highest hill	15 58 0	86 32 43		
Utilla Island, South Kay	16 3 40	86 59 49	6 40	
Cape Triunfo, Bluff Point	15 48 45	87 28 20		
Congrehoy Peak, summit (8,040 ft.)	15 38 0	86 55 33		
CAPE THREE POINTS, N.W. extreme	15 57 45	88 39 24		
Gulf of Dulce, Isabel*	15 24 20	89 10 17	7 10	
Glovers Reef, S.W. Kay	16 42 20	87 51 24	6 50	
„ N.E. extr.	16 55 0	87 44 13		
Half-moon Kay, lighthouse	17 12 12	87 32 48		
Kay Bokel, centre	17 8 50	87 56 24		
Mauger Kay, N.W. end	17 36 15	87 47 3		
English Kay, flagstaff*	17 19 30	88 3 54	7 0	
BELIZE, Fort George	17 29 20	88 11 53		
North Standing Creek, ent	16 57 40	88 14 21		
Cockscomb Mountain, summit (4,000 ft.)	16 48 10	88 38 13		

* These positions may be considered as standard points.

THE COASTS OF HONDURAS, ETC.—CONTINUED.

	LAT. N.	LONG. W.	VAR. EAST, 1878 9.	AUTHORITIES.
	° ′ ″	° ′ ″	° ′	
Sittee Point, Kay	16 47 45	88 15 48		Owen.
Placentia Point, Huts on pt.	16 30 54	88 22 46		
St. George's Kay, centre	17 33 15	88 5 18		
YUCATAN AND GULF OF MEXICO.				
Chinchorro Bank, N. Kay, N. end	18 45 0	87 19 34	6 35	
ASCENSION BAY, Allen Pt.*	19 45 15	87 28 34		
CAPE CATOCHE, N.E. extr.	21 36 0	87 4 30	6 15	
Lagartos, village	21 36 0	88 11 0		
Silan, village	21 23 0	88 55 0		
SISAL, Fort*	21 10 6	90 3 11		
Madagascar Reef, centre	21 26 30	90 19 0		
Alacran Reef, Perez Kay	22 23 36	89 42 19	6 50	
Kay Arenas, N.W. Kay	22 7 10	91 24 54		
Bajo Nuevo Reef, centre	21 50 0	92 5 0		
Triangles, W. reef, Kay at S.W. end	20 58 0	92 19 30		
„ East reef, beacon	20 54 54	92 13 21		
Obispo Shoals, Northern shoal, spot of 16 ft.	20 29 0	92 14 0		
Arcas Kays, Western Kay	20 12 35	91 59 38		
Placer Nuevo or New Bank, centre	20 32 0	91 53 0	7 20	
CAMPECHE, Fort San José	19 51 36	90 31 24		
LERMA, church*	19 48 24	90 36 45		
ALVARADO, bar	18 45 0	95 43 0		
VERA CRUZ, San Juan de Ulda, light-tower	19 11 54	96 8 0	8 10	Lawrance.
Lobos Kay, centre	21 26 0	97 8 0		
RIO GRANDE, entrance	25 57 22	97 7 36	8 40	United States' Coast Survey.

* These positions may be considered as standard points.

NOTES.

GENERAL.—In this section the following may be considered as well-ascertained positions and standard points, viz.:—Demerara Lighthouse; Great Corn Island; Old Providence; Isabel, in the Gulf of Dulce; English Kay; Allen Point, Ascension Bay; Sisal Fort; Lerma Church. In the Tables they are each marked with a star, thus (*).

1. CAYENNE.—The longitude in the Table is inferred from Maranham; the difference of longitude between them having been ascertained by MM. Boussin and Lartigue.

2. COAST between the MAROWYNE and BRAM'S POINT.—To Lieut. B. Greevelink, late of the Netherland's Navy, the public is indebted for a valuable description of the coasts of Guayana and its several ports.

3. From the Bocas de Dragos as far westward as Porto Bello, the longitudes are corrected from the Spanish charts by Don Joaquin Francisco Fidalgo, and must be considered as an approximation only; with the exception of Pena Point, Cartagena, and Caledonia Harbour, which are by Lieut. Lawrence and Mr. Parsons.

TRIBUNE SHOAL.—4. Broken water was also reported by Captain Willoughby, in 1823, N.N.W. 55 miles from Cape Aguja, in lat. 12° 12′ N., long. 74° 32′ W., and reported again by the *Tribune*, in 1827, in lat. 12° 11′ N., long. 74° 26′ W. Nothing could be seen of it by H.M.S. *Blanche*, in 1878.

SECTION II.

LIGHTHOUSES,

AND THEIR ILLUMINATION.

The Lighthouse Systems at present in operation on the shores of the Atlantic Ocean are well worthy of far greater attention than they generally receive, both for the regularity and perfection of their arrangements, and for the beautiful adaptations of science which they exhibit. A few remarks on their nature will, therefore, be an appropriate introduction to the lists and descriptions of the lights which follow.

It is of the utmost importance to the sailor, that one light should be readily and clearly distinguished from another; the melancholy effects of mistakes on this point are too familiar. Every means, therefore, of so distinguishing a light, should be made use of; and one point in furtherance of this, is the system employed in the illumination of the Lighthouses, between the various methods of which it will be seen that there are some well-marked or minor features, which serve to give a distinctive character to lights which may have, otherwise, the same general appearance.

Lighthouses consist of two classes; those built on the land, which do not differ, in the principles of their construction, from ordinary buildings; and those erected on isolated rocks, such as the Eddystone, and those on the Wolf Rock and Héaux de Brehat, which have demanded the most refined judgment and skill to combat with the enormous force of the waves. Another description of erection consists of iron piles, either secured to the rocks or on large screws forced into the sand, which support the Lighthouse. An example will be found in the Maplin Lighthouse, in the mouth of the Thames.

Lightvessels, employed where buildings have been hitherto impracticable, are of peculiar construction, and generally painted *red*, with their name, in conspicuous white letters, on their sides, and carry at their mast-heads one or more skeleton balls, as described, which, in case of the vessels driving, are lowered, in indication of such an occurrence. During fogs or snow storms, from most of these vessels is sounded, at regular intervals, a Chinese gong, the very peculiar and powerful sound emitted by which is not to be mistaken for anything else. Lightships are very strongly moored, either with a single mushroom anchor, or with a span and bridle.

The *lamps* used for the illumination of Lighthouses are upon the principle invented by Argand, about 1780. The smallest of them consists of a single cylindrical wick, of nearly an inch in diameter, and the air is made to ascend through the tube to the centre of the flame, by means of a glass chimney placed around it, and does not differ from that in universal use. This single

wick lamp is used for the parobolic reflectors; and there are usually several of them in a Lighthouse. Where a single and more powerful light is required, a lamp of more complicated construction, though of the same principle, is employed. Both with gas burners, and also with the burners used for mineral or colza oil, the power of the flame can be increased when the weather is not clear. In Mr. Douglass's "single and double-power burner" six wicks are used: they are concentric, the outer one being 5 inches in diameter, or about 15 inches in circumference. The three inner wicks are only for use when increased power in necessary. In the gas burners the increase of power is gained by using additional jets of gas. The colza oil is ex-pressed from the seed of a species of rape or wild cabbage. Formerly the best sperm oil was used in the English lights till 1852.

It seems probable that gas may, at some early day, be more generally used in Lighthouses. This question is, in some degree, dependant on another—the substitution of mineral oil for colza oil. It may be generally stated as the result of the lengthened experiments which have been made at the Trinity House with paraffin as an illuminant for lighthouses. 1. The cost of light is 72.7 per cent. less when produced by the Argand or single-wick lamp, and 60.5 per cent. less when produced in the first-order or four-wick lamp, than colza oil. 2. The lamps burning paraffin will give a light of more uniform illuminating power throughout the night, without trimming, than the lamps burning the colza oil. 3. The lamps burning paraffin are more readily ignited; they burn with greater certainty, and require less attention than lamps burning colza oil. 4. The lamps burning paraffin may be arranged for increasing the power of the light when the state of the weather requires it, as is now done with the electric light and coal-gas. 5. Paraffin can be stored and used at lighthouses with safety, provided that ordinary care is used. 6. That light for light with a first-order lamp, the cost of the paraffin was about one-half that of the colza light. 7. Light for light with the fourth-order lamp, the cost of paraffin was about one-fourth that of colza.

Gas possesses several advantages over the oil flame in its manageability, and the ready way in which its power can be increased or diminished. It may also be so economised, that the appearance of a revolving light can be obtained by merely turning on and shutting off the gas at stated intervals, thus greatly economising the expenditure of the flame. The power of the flame from ordinary gas will not compare favourably with that from the oil lamp; but improvements are being made in the burners.

The Electric Light is the most wonderful of all the means now employed in Lighthouses, whether it is viewed as the result of the most exalted science, or of the consummate skill which has utilised this mysterious agent. Naturally, this very complicated question resolves itself into two distinct portions—the means employed to produce the power, and the apparatus for utilizing it.

It is to the talent and assiduity of Mr. T. H. Holmes that the solution of the difficult problem of maintaining the light steady is owing, and he makes use of *magneto*-electricity as the agent for producing the light.

It would be exceedingly difficult to explain verbally the admirable machine which is now used. Briefly it is this, a series of three or more concentric rings of very powerful magnets are arranged on a frame, 9 or 10 feet in diameter. Between these rings of magnets a corresponding series of electro-magnets, which are formed of soft iron cores, around which the copper wire helices are wound, are made to revolve, being set in motion by a steam-engine. The brass wheels, carrying these bobbins or helices, make 110 revolutions per minute, and at every revolution about 85 lbs. of soft iron are magnetised, by each of the electro-magnets taking up a portion of the power from each of the permanent magnets as it passes close-to, but, of course, without touching them. The magnetic state of the soft iron is changed 4,840 times in each minute. The immense amount of magneto-electricity thus evolved is collected at the axis of the apparatus, and thence passes to the regulator or lamp in the focus of the Lighthouse apparatus.

The magnetic current passes from the machine, thus obscurely described, to the lamp, which holds two carbon electrodes, or pencils, placed perpendicularly one over the other, and between the points of which the light appears. These carbon points are formed of graphite, the substance which is found lining worn-out gas retorts, and consist of nearly pure carbon; they are about $\frac{1}{16}$th of an inch in diameter.

To produce a constant electric light, it is requisite that the carbon points should be maintained separated to a distance proportional to the strength of the current. The intense heat generated

by the electric current liquefies a portion of the carbon, and the current passes from one carbon to another, not through empty space, but through the carbon thus liquefied.

It is in the space between the two carbon points that the light appears, and although they are only $\frac{1}{16}$th of an inch apart, yet in this minute space this splendid effulgence (for it cannot be called a flame) is of sufficient power to entirely eclipse all other artificial lights.

The effect of a lamp in issuing rays, is to fill a sphere whose diameter is double that of the distance to which such a light can be seen. But as only these rays are serviceable which are visible in a horizontal, or nearly horizontal direction, those which pass beyond these limits must be turned into it. To do this we have two alternatives—one to reflect the light by polished mirrors, the other to refract it by glass lenses placed before the light.

When polished silver reflectors are used *behind* the light, it is called the *Catroptric* system, and is that most generally in use in England.

Where glass lenses are used *before* or around the light, it is called the *Dioptric* system, and is that generally in use in France. Hence these two systems are frequently known by the names of the respective countries.

The *Catoptric* or reflecting system is dependent upon the peculiar properties of the parabolic curve, to which the reflectors are formed. The parabola is a conic section which has within it a point called the focus (which is the situation of the flame in the reflector), and if a line be drawn from the focus to any point on the parabolic curve, another line drawn from that point parallel to the axis of the parabola will form an equal angle on either side of it. Now the reflector, composed of copper lined with silver, is formed by the section of the revolution of a parabola; and if a part of light from the focus be reflected from its polished surface, it is thrown off, or reflected in a direction perfectly parallel to its axis. The point of light in the focus thus sends forth a cylinder of light, whose diameter is equal to the double ordinate or opening, or mouth of the reflector. Supposing, then, that we wished to produce a complete circle of light all around the horizon, it is evident that it could not be done with any number of such instruments; there would be dark intervals between the direction of their axes, if they were placed in a circle. But here another circumstance occurs. The flame used is not a point of light, but is nearly an inch in diameter, and this subtends an angle at the vortex (or bottom of the reflector) of 14° 22′, in the reflectors ordinarily used in the Trinity House lights, which are 21 inches in diameter and 4 inches in focal length. Therefore, combined with other circumstances, about 15° or 17° of divergence may be considered effective, and it would take from 25 to 33 of such reflectors of make a complete circle of light.

The brilliancy of the ray from this reflector is considerably stronger in the direction of the axis, that is, when viewed directly in front, than it is for some distance on either side of that direction; and at great distances, in *fixed* lights, when you are in the direction *between* the axes of the adjoining reflectors, the light is frequently glimmering and feeble, but a small change in the position of the ship brings you again into the brighter beam of the reflector, one of which, it will be understood, is only in sight at a time. This is an important observation to the sailor, in distinguishing one fixed light from another, of different descriptions of apparatus.

When a revolving light is required, a number of these reflectors is fixed to the sides of a triangular or quadrangular iron frame, and the whole caused to revolve in regular periods, by means of clockwork. The reflectors on each side of the revolving frame, from four to eight in number, are thus successively directed to every point of the horizon; and the combined result of their rays forms a flash of greater or less duration, according to the rapidity of their revolution.

From the amount of divergence the period during which such a light will remain visible is from 12 to 15 seconds, the light gradually increasing, and as gradually diminishing. And as the action of the reflector is only in the direction to which it is placed, the intervals between the flashes will be quite dark, for a shorter or longer period, according to the distance from which it is viewed, whether it is beyond that to which the unassisted flame will reach.

The light from a revolving catoptric or reflecting system is much brighter than from a fixed light on either principle, as you have the combined effect of several reflectors, each of which gives an equal amount of light, it is calculated, to 350 to 450 such lights, without any reflectors.

In floating lightvessels the light is always shown from parabolic reflectors. These are smaller than those used in Lighthouses, being 12 inches in diameter. For fixed lights, eight lamps and reflectors, each suspended on gimbals, or on ball and socket-joints, so that they always maintain

their perpendicularity. Revolving lights for floating lightvessels have four lamps, and similar reflectors, and the lantern revolves around the mast.

An apparatus for producing an *intermitting* light, of the only appearance to which such a term is applicable, is in use in three of the Scottish Lighthouses, the invention of Mr. Robert Stevenson. It is an arrangement by means of which the light is suddenly obscured by an eclipser, and as suddenly appears again at its full brilliancy.

There is yet another sort of reflector in use in France for harbour lights, called the Bordier Marcet apparatus, from its inventor, or the sideral lamp. It is used with a single lamp, and consists of a circular reflector, about 13½ inches in diameter, formed by the revolution of a parabola around its focus in a horizontal plane; the centre of this is taken out to admit the lamp, which thus has all around it, above and below, a reflecting surface, which sends its upward and downward rays in a horizontal direction.

The lights in the ensuing list, which are upon the catoptric or reflecting system, are distinguished by this mark ●. Their magnitude, or order, is not indicated, as only one reflector is usually visible at a time; the class of the light is to be inferred from its importance.

The first notice we have of the use of parabolic reflectors is given by Mr. William Hutchinson, in his "Practical Seamanship," published in 1777, as having been used in the Liverpool Lighthouses, erected in the year 1763. The formula for the parabolic curve now used was given by Captain Joseph Huddart.

The *Dioptric* or lenticular system is next to be considered, and depends for its action on the refracting properties of glass. In this the apparatus is placed before the flame, and derives its name, dioptric, from a Greek word, signifying anything looked through; or lenticular, from its being composed of lenses. Its principle may be thus explained:—

When a ray of light passes out of a rarer into a denser medium, as from air into glass or water, or *vice versa*, it is refracted, or bent, out of its original direction. Of course, this new direction is dependent upon the direction in which it enters into, or emerges from, this second medium. This is familiarly explained in the burning glass, in which it will be seen that a cylinder of parallel rays of the sun entering one side of the lens, are so deflected, that upon their issuing from it on the other, they form a *cone* of rays whose apex is at a certain distance dependent on the curved side or sides of the lens, called the focal distance.

In the application of plano-convex lenses of 3 feet focus, to the controlling of two-fifths of the entire sphere of light, they must be 2 feet 6 inches in diameter; and, if constructed of the usual form of smaller lenses, would be several inches in thickness in the middle. This would occasion serious inconveniences; a large portion of the light would be absorbed in its passage.

To obviate these difficulties (for a burning glass), it occurred to Sir David Brewster, in 1811, and to M. Augustin Fresnel, in 1819, that the same optical effects might be preserved if a large portion of the solid part of the lens were removed; because the refractive properties of the lens depend upon the relative direction of its surfaces. They therefore proposed the lens now in use for Lighthouse purposes. It is called the polyzonal or annular lens, because it consists of a series of zones or rings, instead of being of one uniform curve or surface. It is a plano-convex lens, having the curved surface cut into rings, which are brought into one plane, and the relative direction of the outer curved surface to the inner flat one is preserved in the separate rings of which the lens is built. There is one great advantage in this method, that the lens may be built to any size, and yet not be thicker, and may be made square, so as to economise every portion of light which may be thrown on the zones of the breadth of their diameter. The dioptric system was perfected by the late M. Augustin Fresnel, the Director of the French lights, and is sometimes called by his name.

From a *revolving* light of the first order, or largest size, eight of these lenses are formed into an octangular belt of 6 feet 0.5 inch in diameter, having the flame of the lamp in their common focus. Therefore, as the action of these lenses is the reverse of that of the burning glass, by sending forth parallel rays of light, which enter the lens in the form of a cone from the focus within; this part of the apparatus will send forth eight beams of light in the direction of their axes, or the lines between the lamp and their centres; between these directions the light will not be seen. The apparatus being made to revolve—say, in eight minutes—by means of machinery it follows that a bright beam, gradually increasing in intensity, and then diminishing, will be presented to the eye each time that one of these lenses passes before it, that is, once every minute.

The duration of these flashes is dependent on the power of divergence in the lens. If the light were a mathematical point, as supposed in the case of the reflector, the flash would last but a single instant; but the breadth of the flame being 3·39 inches, this, at the focal distance of 3 feet, subtends an angle of 5° 9′, and consequently the duration of the flash is while this angle is passing, or about seven seconds. These separate lenses form the principal or most powerful portion of a revolving dioptric light.

For a *fixed* light on the dioptric principle, another adaptation of it is used. As the object is now only to bend those rays, which would pass upwards or downwards into a horizontal direction, and not to interfere with the direction of those which pass laterally, the central portion of the apparatus is formed into a continuous belt, or rather series of belts, whose section is identical with that of the polyzonol lens. It will be evident that such an arrangement distributes the light evenly all round the direction in which it is placed, and thus affords a means of distinction for the sailor, to discriminate such a fixed light from one on the catoptric or reflecting principle, when the light is not quite even all round, but is strongest when immediately in front of the reflector.

The central portions of the apparatus which we have been describing economise about two-fifths of the whole rays issuing from the central lamp, but does not affect those which pass above or below their action, and which would therefore be lost for useful effect without some additional controlling apparatus. This is of two kinds; either *reflecting*, being formed of numerous silvered glass mirrors, or else of *totally reflecting* and *refracting* glass prisms.

In the early period of the introduction of the dioptric system, the more beautiful adaptation of science was alone used for the smaller apparatus, in the form of cata-dioptric or totally reflecting prismatic glass zones, above and below the principal lenses. It has been introduced into the largest apparatus, upon the suggestion of Mr. Alan Stevenson, the engineer of the Scottish Lighthouses, and has most materially increased the efficiency of the whole system.

When a ray of light is thrown on a glass surface at a more acute angle than 41° 49′, instead of passing out again, it is *totally reflected* from that point, and it is of no importance whether it is within the body of the glass or on its external surface. The prismatic zones are so arranged in the form of a cupola over the flame, that the upper and curved surfaces of each of them shall be at such an angle to the focal flame, that the rays issuing from it shall, after being refracted from the under side, be received upon the inner surface of the upper side, be again refracted, and issue from the outer side in a perfectly horizontal direction.

In a revolving lenticular light, therefore, the upper and lower portions the apparatus, affording a constant and steady light, are visible in the intervals between the flashes from the central lenses, and this subordinate light will serve to fix the position of a light during such interval, if it is seen within the distance of 8 or 10 miles. This distinguishes a lenticular revolving light most clearly from one on the catoptric principle, or from parabolic reflectors, the intervals between the flashes of which are generally total beyond the distance of 2, 3, or 4 miles.

There is a more complicated system in use for dioptric revolving lights, which, although there is no example of them in the English Channel, as they are in use in the two finest Lighthouses in the world, the Cordouan, at the mouth of the Gironde, and the new Skerryvore, off the West Coast of Scotland, we will here describe. Instead of the bands of parabolic mirrors, or cata-dioptric zones, *above* the central and principal lenses, the apparatus is dia-catoptric, being composed of eight smaller lenses of 19½ inches of focal distance, inclining inwards towards the flame, and forming an octagonal frustrum of a cone of 50° inclination. These are, or were, surmounted by plane mirrors, placed so as to reflect horizontally the beams transferred by these lenses. The whole of the apparatus is caused to revolve in eight minutes. Within 8 miles a constant steady light is seen, and in each minute a small and a large flash are visible.

Among the French system of lights is an apparatus which shows a fixed light, varied by a bright flash at regular intervals. The apparatus consists of the ordinary fixed dioptric light with the refracting belt, which is composed of *horizontal* cylindrical elements. Round this central belt one or more panels of *vertically* cylindrical elements is made to revolve. This revolving panel causes the horizontally divergent beams to be parallelized in azimuth, and thus the appearance of the light from the entire apparatus will be a fixed light, then a short eclipse caused by the deflection of the section of light by the revolving panel, then the bright flash from the panel, then another short eclipse, and then the steady light again. The same appearance is also more effectually produced by constructing the apparatus of alternate segments of horizontal cylindrical

elements and polyzonal lenses. Sometimes the flash is of a red colour, the revolving panel being stained for that purpose, as in the case of the light on Chausey, and several others.

The only means of distinguishing one light from another is that of causing it to revolve or flash at different intervals, as is almost exclusively used in the French lights, or by means of colour, as is more in use in our own harbour and tide lights. The colour which alone seems adapted for this purpose is *red*, and this is applied to dioptric lamps by a cylinder of ruby-coloured glass, stained with a preparation of gold, placed around the lamp; or if to the ordinary reflector, a pane of this coloured glass is placed before the reflector. The use of colour is objectionable on the score of the greatly diminished power of such a light. In a revolving light, and showing alternate bright and red flashes, these last will not be visible so far off as the bright flashes, if the powers of the flame are equal. In the Wolf Rock and Flamborough Head lights, the red and bright flashes are equalised by making the quantity of light for the red beam in proportion to the bright ray, as 5,275 is to 2,250, or as 21 to 9 nearly.

There was some waste of light in both the systems. In the year 1849, Mr. Thomas Stevenson, son of Robert, brother of Alan Stevenson, proposed some arrangements which obviate this loss, upon what is termed the *holophotal system.**

Proceeding upon the assumption that the whole of the emitted rays from the central lamp may be made to assume the horizontal direction, Mr. Thomas Stevenson has made several most excellent arrangements, which, however, we cannot fully describe here. The simplest form is that of an hemispherical metallic reflector, in the focus of which is placed the lamp; before the lamp is a refracting polyzonal lens, of such a section that the whole of the direct rays from the lamp, and the reflected rays from the posterior reflector, are parallelized on their emergence.

Fresnel's revolving light system, as at work in the Skerryvore and the Cordouan, with its beautiful but complicated upper system, is rendered holophotal by a very simple means. The zones above and below the main lenses act in the same way as the central lens; that is, these zones, being made horizontal, are made of segments of circles concentric with the centre of the great lens beneath and above them; and by the whole apparatus revolving, nearly the whole of the light is projected horizontally in the eight directions of the octagonal prism; and, therefore, when each face is presented to any point, the whole of it is luminous.

The lantern or light-room was greatly improved by Mr. Alan Stevenson, at the Skerryvore, by the introduction of the diagonal framework of the lantern. The glass was made in triangular panes, fixed in gun-metal framework, which, although necessarily massive, by crossing the light diagonally, did not obscure the whole of the perpendiculor beam, as was the case with the older light-rooms. This drawback has been reduced to a minimum by Mr. James N. Douglass, in his system, which consists of a series of lozenge-shaped panes, supported by steel frames, bent to the curvature of the lantern, and thus presenting only the thinnest possible edge towards any point of the horizon. These spiral bands hold the pane of glass, which is also bent to the curve of the light-room, and accurately ground to the size of the frame; and the lantern is thus built up of separate elements, which unite to form a cylinder of the strongest character, and the framework of which, from a short distance, will be entirely invisible when seen in front.

Dioptric lights are divided into four, or rather six orders, according to their magnitude:—

1. The *first* order apparatus is 6 feet 0.5 inch in diameter, and is illuminated by a lamp with four wicks, of 3·39 inches, 2·52 inches, 1·69 inches, and ·83 inch in diameter, respectively. It is indicated in the following list by the figure 1.

2. The *second* order apparatus is 4 feet 7·13 inches in diameter, and is illuminated by a lamp with three wicks, of 2·6 inches, 1·8 inches, and ·9 inch in diameter, respectively, and is indicated by the figure 2.

3. The *third* order is sub-divided into two sizes, larger and smaller. The first apparatus (grand modèle) is 3 feet 3·38 inches in diameter; and the second (petit modèle) 1 foot 7·69 inches in diameter. They are each illuminated by a lamp with two wicks, the larger of 1·61 and ·807 inches in diameter, respectively, and the smaller of 1·20 and ·589 inches in diameter. They are shown in the list by the figure 3. All the lights of this order in the English Channel are of the larger size.

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* "Holophotal" from two Greek words, signifying "whole light."

4. The *fourth* order, or harbour light, is also subdivided into two sizes, the larger (grand modele) 1 foot 2·77 inches in diameter, the smaller (petit modele) 11·81 inches in diameter. They are illuminated by a single cylindrical wicked lamp of ·94 inch or ·85 inch in diameter. As the sub-division of this order is unnecessary to the sailor, it is distinguished in the list by the figure 4.

In addition to the magnitude of the apparatus, the description of it will also serve usefully to distinguish one light from another. Therefore, the different systems employed, as described in the foregoing paragraphs, are designated by the letters a, b, c, attached to the figures indicating their sizes, as follows:—

a. A *fixed* dioptric light apparatus, having a dioptric belt and cata-dioptric prismatic zones. This is the most perfect system for fixed light apparatus.

b. A *revolving* light apparatus, consisting of polyzonal lenses, surmounted by the cata-dioptric prisms. The appearance of this light, beyond the distance of 8 or 10 miles, according to the size of the apparatus, is that of a brilliant flash of 7 to 9 seconds' duration. Within that distance the fainter light between the flashes is visible.

c. A *fixed* light, varied by *flashes*. Its appearance, which distinguishes it from any other, upon close attention, is, 1st, the intensity and duration of the fixed light; and, 2nd, by the *short* duration of the eclipse which precedes and follows each brighter flash.

The range (portée) of the different lights, as given in the table, represents this element very incompletely, inasmuch as the distance there given is dependent on the elevation of the light, and consequent distance of the horizon. The flashes of the principal revolving dioptric lights may be, and have been, seen 50 or 60 miles off, when they are above the horizon, and it may be taken for granted that, should the atmosphere be favourable, any of the larger lights may be seen from whatever distance they may be sought for from the greatest attainable elevation.

The height of the lights above the sea-level is given in the tables from the level of *high water at spring tides*, and consequently in their minimum height. This will cause the distance to which they are visible to be increased (with the exception of floating lights) when it is low water, by an amount equivalent to the depression of the sea surface at that period.

Atmospheric changes, of course, have the most important effect on the range, visibility, and appearance of lights. In a very clear transparent atmosphere they will have nearly a white appearance; during foggy weather, particularly the dry haze sometimes predominant on soundings, they will have more or less of a yellow or reddish tinge.

Lights may be divided into three classes according to their mutual importance:—1. *Coast lights*, those which serve for the mariner to recognise the land on approaching it, and are thus of the greatest power; they are marked in the following lists in capital letters, thus—**USHANT, LIZARD**, &c.

2. *Harbour and Leading Lights.*—These of less importance than the former in the general system, are used to indicate a port or narrower channel. Some of these, though more limited in their immediate object, may be as important as the first class. Thus the Gull Stream light-vessel, though of limited approaches, is most useful in marking the centre of the Goodwin; it is therefore placed among the first class. The second class is shown in smaller letters, as—Shoreham, Cherbourg, &c.

3. *Tide lights* show when the harbour has a certain depth of water, and is accessible. They are frequently red, and, consequently, are of less power. They are marked in italics, as *Ramsgate, Boulogne*, &c.

Further details are given in the New Edition of our Work, "A Description and List of the Lighthouses of the World," to which the reader is referred.

EXPLANATION OF THE TABLES.

—o—

NAME AND CHARACTER OF LIGHT—First Column.

The principal coast lights are given in capitals, as **N. FORELAND.** Secondary lights in smaller characters, as **Shoreham Harbour.** Tide lights in italics, as *Ramsgate.* The character of the light follows its name.

GEOGRAPHICAL POSITION—Second Column.

The latitudes and longitudes here given are presumed to be accurate, within less than 1′, for all the coasts of the Atlantic Ocean and its Seas. In other parts of the world it may vary somewhat more ; but there is no great discrepancy, such as would lead to serious consequences, by taking any one of them as a point of departure.

DESCRIPTION OF THE LIGHT, &c.—Third Column.

In this, any peculiarity of the light, or period of a Tide light, is noticed; and also the direction of double lights. In many cases the bearing of two lights when in one will lead clear of a danger, as the South Foreland in one, W. by N., clears South end of the Goodwin, &c. Special directions will explain this. The limits of visibility of the lights are given by compass bearings *from* the light, and not those from seaward.

DESCRIPTION OF APPARATUS—Fourth Column.

In this, the signs used to indicate the sort of light apparatus in use in each case:—

- ● signifies a catoptric, or reflector light.—(See page 14, &c.)
- 1a, 2, 3 b, &c., indicate dioptric, or lens lights, the figure showing the order or size, 1st, 2nd, 3rd, to 6th order.—(See page 19.)
- a, a fixed lenticular light.—(See page 21.)
- b, a revolving lenticular light.—(See page 25.)
- c, a fixed and flashing light.—(See page 23).

These figures and letters will serve to explain the peculiarities of the Lenticular System, as in operation therein.

HEIGHT ABOVE HIGH WATER.—Fifth Column.

This gives the height of the *flame* in feet above the highest tide level, consequently it is its minimum height, and is increased by the tidal range of the place. The height of the Lighthouse itself, from base to summit, is given sometimes in the third column.

VISIBLE IN MILES—Sixth Column.

This gives the minimum distance to which the light can be seen, in clear weather, from a height of 10 feet above the sea level. But in the case of the principal lights this but imperfectly represents their range, as they could be seen at any distance attainable by increased elevation. In the use of *coloured* lights this range is given according to their presumed power.

YEAR ESTABLISHED—Seventh Column.

The date of the first exhibition of the light is usually given; but its character, &c., may have been frequently changed in the interval.

LIGHTHOUSES.

1881.

ENGLAND. **Thames Mouth.**

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
RIVER THAMES Northfleet	.....	Bright light in fairway of Northfleet Hope and Gravesend Reach; red over anchorage in Gravesend Reach and Broadness..	○	..	..	1859
Hope Point Fort	.....	A single lamp for colliers.....	..	..	..	1852
Mucking Flat One occulting light, ½ min.	.....	On piles; bright East of N.E. by E., red to W.; also red ray toward Blyth buoy to S. ½ E., and red North of E.S.E. to clear Scars and Chapman Head. Lt. eclipsed 3 secs. in ½ min.	2a	40	11	1849
Chapman Head One occulting light, ½ min.	.....	On piles. Bright in fairway channel, red over Leigh Middle to N. of S.E. by E. ½ E. Lt. eclipsed for 3 secs. twice in every ½ minute	2a	40	11	1849
Southend Pier-head	.....	Red fixed light	..	..	..	1840
Sheerness	.....	Red gas lt. on N.W. face of fort on Garrison Point. Not vis. S. of N.N.W. bearing.	..	50	5	1859
Queenborough	.....	1. Two red leading lights on pier.....	..	..	3	1876
		2. A bright lt., vis. through 45°, is shown from beacon on Queenborough Spit, in 6 ft. water, 80 yds S.W. from Spit buoy	6a	30	5	1876
Whitstable	.....	Bright fixed light on tall chimney	●	56	9	1850
NORE LIGHTVESSEL One br. rev. lt. ½ min.	51 29. 0 48.	In 3¾ fathoms at East end of the Nore Sand.	●	38	10	1732
Girdler Lightvessel One br. rev. lt. ½ min.	51 29. 1 7.2	In 3½ fathoms W. Girdler Sand at W. entrance of Princes Channel.	●	38	10	1848
Princes Channel Lt.-Ves. One *red* rev. lt. 20 secs.	.....	In 3½ fms. N. side of channel, betw. Girdler & Tongue lightvessels.	●	38	10	1856
Tongue Lightvessel Upper bright, lower *red*, fixed lights	51 29. 1 19.6	In 10 fms. at East Tongue Sand; one red hall. Lts. at unequal heights.	●	38 14	10 4	1848
Margate Pier One *red* fixed light	51 24. 1 23.	Column at W. end of Pier; also a small green light on Jarvis Jetty	○	85	10	1829
Mouse Lightvessel One *green* rev. lt. 20 s.	51 32. 1 0.	In 4 fms., at W. end of Sand.	●	38	10	1838
Maplin Pile Lighthouse One *red* fixed light	51 35. 1 3.	Painted red; lt. not vis. over the sand; a br. ray to S. ¾ W. betw. Girdler Lt. & Shivering Sand buoy. Br. lt. shown 13 ft. below main lt. to S.E. by E. ¾ E. over Spit buoy.	2a	36	10	1838
Swin Middle Lightvessel One br. rev. lt. ½ min.	51 38 5 1 6 5	In 5½ fathoms at West end of Sand.	●	38	10	1837
Gunfleet Pile Lighthouse One *red* rev. lt. ½ min.	51 45.8 1 20.6	On S.E. side of Sand; keep ¼ mile off, and do not pass to North.	●	41	10	1850

All the lightvessels belonging to the Trinity House, and those of Ireland, show a bright riding lt. on the fore-stay, at a height of 6 ft. above the rail, to show the direction in which they are riding. Should the vessel drive from her proper position, she will only show a fix. red lt. at each end of the vessel, and a red flare ev. ¼ of an hour.

Lightvessels, placed to show Wrecks, and painted green, will show 3 bright lts. or 3 balls, two vertically on the side on which they should be passed, and one on the other.

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Mile-.	Year established.
Sunk Lightvessel One rev. light, 45 secs.	51 49 6 1 31.1	In 9½ fathoms; red and bright flash alternately; half ball above ball.	●	37	10	1802
Kentish Knock Lt.-Vessel One br. rev. lt. 1 min.	51 41. 1 41.	Has two red balls vertically. In 11 fms., on E. side of Sand.	●	37	10	1840
GALLOPER LIGHT-VES. Two bright fixed lights	51 45. 1 56.	In 20 fathoms, on S.W. side of Shoal; lights horizontal.	●	36	10	1803
NORTH FORELAND One occulting br. or *red* lt., ½ min.	51 22.5 1 26.8	White tower, 85 ft. high. A strip of red lt. to E. end of Margate Sand, betw. N. ¾ E. and N. by W. ½ W. Lt. eclipsed for 5 secs. in every ½ minute	1a	188	19	1636
Ramsgate, Tide Lights 1. *Red* or green light on West pier 2. *Green* lt. on W. cliff 3. *Green* lt. on E. cliff 4. Sparkling lt. 10 secs., on East pier	51 19.7 1 25.4	1. Red lt. while more than 10 ft. in entrance, or from 2¼h. before, and 3½h. after high water; changed to green lt. when less than 10 ft. 2. Green lt. in one with W. pier lt. leads through Old Cudd Channel 3. Green lt. in one with ditto leads through Ramsgate Channel 4. Visible 5 secs., invisible 5 secs.	4a	38	7	....
GOODWIN LT.-VESSEL One br. rev. lt. 1 min.	51 19 4 1 35.5	Off N. end of the Goodwin Sands, in 10 fms. Lt. shows 3 flashes in quick succession, and is obscured for 36 secs. in ev. min. Three masts & balls by day.	● ..	36 ..	8 ..	1793 1876
EAST GOODWIN LT.-V. One *green* rev. lt. 15 s.	51 13. 1 36.4	About 1½ mile to the eastward of the Goodwin Sands, in 30 fathoms. Half diamond over diamond at mast-head.	●	37	..	1874
GULL STREAM LT.-VES. One br. rev. lt., 20 secs.	51 16.5 1 30.	On the West side of the Goodwin Sands, in 8 fathoms.	●	36	10	1809
S. SAND HEAD LT.-VES. One bright fixed light	51 9.2 1 28.2	Off the South end of the Good in Sands, in 14 fathoms.	●	34	10	1832
Deal Iron Pier	.....	Red light on pier head	..	..	..	1865
SOUTH FORELAND Two ELECTRIC FIX. LTS.	51 8.4 1 22.4	In one W. by N., 1,347 ft. apart; in one, clear S. of Goodwin. High lt. cut off on a S.W. by S. bearing. Magneto-electric apparatus	3a 3a	372 275	26 23	1793 1812
DOVER Admiralty Pier Fix. & fl. br. lt. 7½ s.	51 6.5 1 19.	Red tower, 30 ft. high, on end of Admiralty Pier.	● ..	.. ..	.. ..	1842 1852
Dover Harbour One *green* light *Red Tide Lights*	.....	One red lt. on N. pier while 7 ft.; one red lt. on S. pier while 7 to 10 ft.; two red lts. while above 10 ft. The green lt. at the W. side of entr. to Granville Dock	6c	44	6	1876
Folkestone Tide Lights 1. *Red* and bright lts. 2. *Green* light	51 4. 1 11.6	1. On S. pier head a red light while 10 ft.; a white light below it when above 16 ft.; when red lt. is blinked occasionally use caution ... 2. On new pier a green light seaward, but white inshore of danger	● 5a	37 33 31	6	1810 1860
VARNE LIGHTVESSEL One *red* rev. lt. 20 secs.	50 56.3 1 16.7	In 16 fathoms at West end of the shoal.	●	38	10	1800
DUNGENESS 1. One fixed light 2. One br. flash. lt. ev. 5 secs.	50 54.8 0 58.3	1. Tower with red and white belts, 240 yds. from extr. of point. Red lt. over W. anchorage northward of W., and red lt. over E. anchorage W. of N.E. by E. ½ E. 2. New tower on extr. of pt. S.S.E. ½ E. 675 ft. from main lt.	1a ..	92 28	15	1791 1861 1867 1875
Rye Tide Lights 1. Two bright fixed lts. 2. Two *red* fixed lights. 3. One *green* fixed light	50 57. 0 44.	1. Camber, on N. side of the entrance while 10 feet; in one N. ½ W. 2. Near old pier head from half flood to half ebb 3. West entrance to harbour half flood to half ebb	.. .. ..	26 16 32	4 3 ..	....

Name and Character of Light.	Lat. N. Long. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
	Long. E.					
Hastings	50 52.	On West Hill, in one, N.N.E., 508 ft. apart, to	..	60	7	....
One bright, one *red* lt.	0 36.	direct the fishermen (Sept. 29 to Mar. 25)...	..	30	4	
		A green light on the pier.....				
R. SOVEREIGN SHOALS	50 42.8	In 12 fms., S. Ely, 2 miles from R. Sovereign	..	36	10	1875
One revol. br. lt. 1 min.	0 26.7	buoy. Shows 3 flashes in 23 secs., at intervals of 37 secs. Small ball over usual masthead ball.				
Eastbourne	.....	A green light is shown on the pier, and two red lights on the beach.....	..	..	..	....
BEACHY HEAD	50 44.2	A white lighthouse, 47 ft. high, on summit of	●	285	22	1828
One br. rev. lt., 2 min.	0 12.9	Belletout Cliff. From the eastward the lt. will open when bearing N.W. ¾ W., and by keeping it so will lead 1¼ mile outside Royal Sovereign Shoals				
Newhaven	50 47.	On West pier-head. Tide lt. below main lt.	●	28	8	....
One br. fix. lt. and *Tide Light*	0 4.	red betw. 10 and 13 ft., bright betw. 13 and 15 ft., and green above 15 ft.	..	17	7	
Green light on E. pier						
	Long. W.					
Brighton Chain Pier	50 49.	One green fixed light	..	35	10	1824
„ Pile Pier	0 8.	One red fixed light.....	..	..	5	....
Shoreham Harbour	50 50.	Tide lt. on central pier, green while 8 to 11 ft.,	4a	42	10	1825
One bright fixed light, and *Tide Light*	0 15.	bright while 11 ft. and over, and red at high water; bears S. by W. ¼ W. from upper lt.	..	23	..	....
Two green lights		Two green lts., one on E., one on W. pier-head. Approaching, keep high br. lt. open E. of W. pier green lt., and when clear of W. pier-head, keep near the pier until high lt. and tide light come in line				
Worthing Pier	.....	Fixed light on the pier.....	..	..	..	....
Littlehampton	50 48.	Also tide lts. on S. end of pier; white 10 feet,	●	30	9	1848
Red lt. on E. pier, N. end	0 32.	green 11 ft., red 12 ft., red & white 13 ft., two white 14 ft., white & green 15 feet, till H.W.				
OWERS LIGHTVESSEL	50 38.7	On the S.E. end of the Owers Shoal, in 19 fms.	●	38	10	1788
One revolving lt. ½ min.	0 39.9	Flashes twice bright, once red.				
Nab Lightvessel	50 42.2	Near New Grounds; must be passed to east-	●	38	10	1812
Two bright fixed lights	0 59.3	ward.		28	8	1865
ST. CATHERINE'S PT.	50 34.5	Stone tower. Lt. vis. betw. E. ¾ S. and N.W.	1a	134	17	1840
One brilliant fixed light	1 17.8	¾ W.				
Warner Lightvessel	50 43.8	In 13 fms., on the eastern part of the shoal.	●	38	8	1854
One br. rev. lt. 1 min.	1 4.					
Ryde Pier	.....	A bright fixed light	5a	21	12	1852
SPITHEAD	.....	Green lt. on fort at Brading Haven; br. lt. on	..	..	..	....
		No Man's Land Fort, with red sector of 14° over Ryde Sand Head & Sturbridge Shoal; red lt. on Horse Sand Fort; red lt. on Spit Sand Fort.....				
Stokes Bay Pier	.....	Red lights on East and West ends	..	..	..	1865
Southsea Castle	50 46.6	Shows red in channel between Spit Refuge	●	51	9	1822
One *red* fixed light	1 5.2	Buoy and Horse Fort, or to betw. S. by W. and S.W. by S. It is green to West of the Spit Buoy betw. S.W. by S. and W. ¼ S. ...				
Southsea	.....	Two red lights on Clarence Esplanade Pier ...	..	..	..	1869
Portsmouth Dockyard	.....	On S. end of S. railway jetty. Shows red betw.	..	..	..	1878
One fixed *red* or *green* light		the eastern side of the harbour and S.E. tangent of Block House fort, and green westward of that line. Harbour railway works will be cleared by keeping in green light ...				
SOUTHAMPTON WATER						
Calshot Lightvessel	50 48.	Off Calshot Castle, in 3½ fathoms.	●	32	9	1842
One br. rev. lt., 1 m.	1 16.					
Netley Pier	.....	One fixed green light to be shown	..	..	..	1878
Southampton	50 53.7	1. On either side of entrance to Docks. In one	..	..	..	....
1. Two fixed *red* lts.	1 24.4	N.N.E. ¾ E. lead up River Itchen in 15 ft....	..	..	..	1876
2. Two fix. *green* lts.		2. On Extension Quay, N.W. side of R. Itchen	..	..	..	1877
3. One fixed *red* lt.		3. From Harpy lt.-ves., at entr. of Riv. Itchen	..	..	..	1841
4. Two fix. bright lts.		4. From iron posts on Royal Pier, 15 yards apart. In one lead up channel	..	..	..	

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Yarmouth Two fixed lights	.....	Green outer lt. near castle wall; inner br. lt. In one S.S.W. lead into the harb. Temporary lt. on end of wooden pier constructing	..	12	..	1857
Needles Outer Rock One fixed bright, or *red* light	50 39·7 1 35·5	Shows red to S. from S.E. ½ S. to W.; then bright over entrance of Needles Channel to W.N.W.; thence red up the channel to N.E. by E., and then bright to N.E. by E. ½ E., to clear Warden Ledge.	1a	80	9	1859
Hurst Beach Two bright fixed lights (Low lt. in New Fort)	50 42.4 1 32.9	In one N.E. by E. ½ E., 670 feet apart. Another light in the lighthouse shows only up the Solent	● ●	66 46	12 11	1812 1866
Poole Two *red* lights	50 41. 1 58.	In one, N. ½ W., 786 ft. apart on North side of entrance; also four lights inside	● ..	37 16	6 ..	1848 ....
DURLSTON HEAD One flash. br. lt., 10 secs. (Building)	50 36. 1 57·5	Lt.-ho. on Anvil Point, W. part of Head. A flash every 10 secs. betw. about W. ½ N. and E. by N. (To be exhibited in 1881)	1b	149	18	1881
Weymouth Two *red*, two *green* lts.	50 37. 3 26.	Two red lts. near beach, E. of railway station Two green lights on North pier	..	..	..	...
PORTLAND High lt., br. and fixed Low lt., br. and fixed	50 31·3 2 27·3	White towers, 50 & 85 ft. high, 1,509 ft. apart, near the Bill. In one, N.W. by N., lead betw. Race and Shambles. Low lt. only shown between N.W. by N. ¾ N. and E.S.E.	1a 1a	210 136	21 18	1716 1789 1867
Portland Breakwater One fixed *red* light	.....	Shown from centre of fort at end of Breakwater. Lt. obscured by peninsula between S.S.W. & W. by S. ½ S., & betw. W. by S. ½ S. & W.N.W. lt. is obscured to an observer 15 feet above the sea when within 2 miles of Chesil Bank.	●	51	8	1851 1876
Shambles Shoal Lt.-Ves. One fixed light	.....	On E. end of shoal, in 15 fms.	●	38	10	1859
Lyme Regis Two *red* lights	50 43·5 2 55·9	In one, N.W. ½ N., 825 ft. apart. A bright leading light in centre of channel, N. ¼ W.	.. ..	11 21	4 ..	1853 ....
Teignmouth Two *red* fixed lights	50 32.6 2 29.6	One on a limestone tower on S.W. end of Denn; the other on a house	●	34	4	1845
Brixham *Red* fixed lights	50 24. 3 30.	On the pier-head and on inner pier	○	20	6	1839
Torquay One *red*, one *br.* fix. lt.	50 27.5 3 31.	Bright light on inner pier, showing red to westward; red light on outer pier	..	15	5	1852 1870
Dartmouth 1. One fixed bright *red* or *green* light 2. One bright fix. lt. 3. One small bright, *red*, or *green* light	50 20.3 3 33.2	1. On Kingswear or N. side; br. lt. towards fairway, between S. ¾ E. and S. by E. ¼ E.; thence red lt. to the land, and green lt. to S.W., between S. ½ W. and the land, or over Checkstone, Pin Rock, &c. 2. S. ¾ E. 110 ft. from former; in one leads up fairway 3. Near Coast-guard Station; br. in fairway, red over shoals on N. side of harbour. and green lt. over shoal of One Gun Point to S.	..	85 70	11 ..	1864 ....
START POINT One brilliant revol. lt., visible every minute	50 13.3 3 38.5	A white tower, 92 ft. high. A fix. lt. at 181 ft. is also vis. from tower over Skerries Rocks betw. N.E. ¾ E. and E. ½ N.	1a	204	20	1836
Plymouth Breakwater One occulting bright or *red* light, ½ min. Lower bright light	50 20.4 4 9·5	On W. end; bright to seaward, betw. E. by S. ¼ S. and N.E. ¼ E., through S., and red over the anchorage; lt. eclipsed 3 secs. every ½ min. A lower br. lt. is seen when channel is open	2a ..	63 48	9 ..	1844 ....
Plymouth Harbour Two bright, two *red* lts.	50 22. 4 7.	On W. Barbican pier-head is shown a br. lt., a red lt. on Millbay pier-head, & also one at Mt. Wise landing. Fixed br. lt. on extr. of Mt. Batten Breakwater works	●	29	6	1822
EDDYSTONE One brilliant fixed light	50 10.8 4 15·9	An admirable stone tower, with red and white bands, 89 ft. above foundation on the rock, which covers 14 ft. at high water. Light is obscured, by new lt.-ho. in course of erection, for an arc of 10° between S. by E. ¼ E. and S.E. by S. ⅞ S.	2a	72	13	1759
Falmouth One *rev. lt.* 20 secs. Lower fixed light One *green* fixed light	.....	On St. Anthony Pt. The lower lt. to S.S.W. over Manacles Rocks, between S.S.W. ½ W. and S. by W. ¼ W. On Prince of Wales breakwater	●	72 35 ..	12 10 ..	1835 1865 1860

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
LIZARD Two electric fixed lts.	49 57.6 5 12.1	Two white towers, each 61 ft. high, W. by N. & E. by S., 223 ft. apart, on the Lizard Cliff. In one lead clear of the Manacles. A signal and telegraph station on Beast Point, about ¾ of a mile to E.	● ●	229 232	20 20	1751
WOLF ROCK One rev. lt. 30 secs.	49 56.7 5 48.2	A noble granite tower. Flashes red and white alternately.	1b	110	16	1870
Penzance Tide Light A fixed *red* or br. light, while 15 ft. inside; *green* while less	50 7. 5 31.	On the S. pier-head. Shows red to E. by S. ⅜ S. to S. by W. ¼ W. The remainder a bright light. By day, a ball while 15 feet	5a	33	9	1817
LONGSHIPS One fixed light	50 4. 5 44.7	New tower, 1873. White lt. seaward, from N.N.E. ½ E., or ½ mile W. of Brisons Rocks, to S. by E., or ¾ mile W. of Runnelstone; red in-shore of these bearings.	1a	110	16	1795
SEVEN STONES LT.-VES. One group-flashing br. light	50 3.2 6 5.3	On E. side of rocks, in 40 fms.; two red balls. Shows 3 quick flashes, followed by 36 secs. darkness ev. min.	b	36	10	1841 1879
SCILLY One br. rev. lt. ½ min.	49 53.5 6 20.7	A white tower, 74 ft. high, on summit of St. Agnes' Id.; obscured by Ids. from N. by E. to E.	●	138	16	1680
BISHOP ROCK One fixed bright light	49 52.5 6 26.6	On the S.W. rock. A noble stone tower, 147 feet high. Invisible to eastward between N.E. by E. and E. by S. ¼ S.	1a	110	16	1858
St. Ives Tide Light 1 br. fix. lt. while 10 ft.	50 12. 5 28.	On the pier head. Lighted from Sept. 1 to April 30. Also a red light on end of outer wooden pier	●	23	7	1831
Hayle Tide Lights 1. Two fixed bright lts. 2. One fixed red light	50 11.5 5 26.	1. On W. side of entr.; in one S.S.W. ¼ W., 297 ft. apart, while 12 ft. water..... 2. On jetty of Lelant Quays	● ..	81 59	6 ..	1840 ....
GODREVY One br. flash. lt., 10 secs. Lower *red* light	50 14. 5 24.	On the island. Lower red lt. to N.W. over the Stones Rocks, between N.W. and N. by W.	1c ..	120 93	15 ..	1859 ....
Padstow	.....	A red or green light on quay head	..	..	..	1868
TREVOSE HEAD Two bright fixed lights	50 32.9 5 2.1	The lower light is 50 feet to seaward of the upper.....	1a 1a	204 129	20 17	1847 ....

BRISTOL CHANNEL.

HARTLAND POINT One rev. lt., ½ min.	51 1.4 4 31.5	New tower, showing at intervals of 30 secs. two bright and one red flash.	1b	120	16	1874
LUNDY ISLAND Upper lt, rev. ev. 2 m. Lower fixed light	51 10.0 4 40.3	In one tower, 96 ft. high. Low light visible to W. between N.N.W. and W.S.W.	1b ●	540 470	31 ..	1820 ....
Bideford Two bright fixed lights	51 4. 4 12.	On Braunton Sands, N. side of entr. In one, S.E. ¼ S., lead over bar. High lt. vis. betw. W.S.W. & N.N.W.; obscured betw. N.N.W. & E. ¼ N., over Baggy Leap & Asp Rks.; a lt. of less power vis. in harb. from E. ¼ N., through S., to W.S.W. Low lt. shown only from half flood to half ebb	● ..	86 40	14 11	1820 1879
BULL POINT 1. One group-flashing bright light 2. Lower *red* lt. fixed	51 11.9 4 12.1	1. Light shows three quick flashes, followed by 18 secs. darkness, ev. ½ min. ..... 2. Lt., 18 ft. lower, shows betw. W. by S. and N.W. by W. ½ W., to mark Morte Stone.	1b	154	20	1879
Ilfracombe	.....	One red light on Lantern Hill	●	127	7	....
Watchet Breakwater	.....	Tide light fixed, 8 ft. flood to 10 ft. ebb	..	30	4	1862
Burnham, or Bridgewater Up. lt. intermit. 4 min. Lower light fixed	51 14.9 2 59.9	In one, E. by S. ½ S., 1,500 ft. apart. Low lt. bright, visible westward from W. by N. to N.W. by W. ¾ W.; a red lt. from low tower shows over the bar from W. ¾ N. to W. ¼ N.; and a red lt. up the river from S. by W. to S. by W. ½ W.	● ..	91 23	16 9	1832 ....

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Clevedon	.....	Red light on pier-head	..	27	5	1869
Portishead	.....	Bright light on pier	..	..	..	....
Breaksea Lightvessel One br. rev. lt. 15 secs, One *red* fixed light	51 19.8 3 17.6	In 8 fms. 2 miles W. by N. ½ N. from One-fathom Bank buoy; one ball; red lt. shown from after part.	● ..	38 14	10 7	1866 ....
Avon One occulting br., *red*, or *green* light, ½ min.	51 30. 2 42.2	White tower, 65 ft., on E. side of channel. A red sector to N.W., and a green ray from W. to W. by S. at turn of channel. Lt. eclipsed 3 secs. in every ½ minute	2a	70	13	1840
English & Welsh Grounds Lightvessel One br. rev. lt. 1 min.	51 26.5 2 58.	On S. side of Bristol Channel, in 14 fathoms; a red ball,	●	38	10	1838
New Passage	.....	Lights on pier and Charstone Rock for railway steamers.....	..	..	..	1863
River Severn 1. *Sharpness Docks* 2. Severn Rlwy. Bridge	.....	1. One fix. tide lt. on N. pier-hd. of tidal basin. 1 red lt. N.E. of pier when specially required 2. Red lt. on centre pier, and br. lt. at landward extreme of each wide arch	..	..	..	1879
FLATHOLM One occulting bright or *red* light, ½ min.	51 22.5 3 7.	On South point. Light is red from S. ¼ E. to N. by W. ½ W. Lt. eclipsed 3 secs. twice in every ½ minute	1a ..	156 ..	18 ..	1737 1839
Briton Ferry	.....	North side of dock entrance; red light when passage is clear; green light when not open	..	..	..	....
Usk, Newport One bright or red light	51 32. 3 3.	West side. Light bright in channel, red over Welsh Grounds and Welsh Hook; bright North to land; bright up river	.. ..	30 ..	10 ..	1821 1868
Cardiff Two *red* fixed lights	51 27.8 3 9.7	About 23 yards apart. One on pier-head	..	..	..	1866
NASH POINT Two bright fixed lights One *red* light	51 24. 3 33.	White towers 1,000 ft. apart, S.E. by E. ¼ E., and N.W. by W. ¼ W. ..... Red light from high lighthouse from N.W. by W. ⅛ W. to N.W. ⅛ W.	● ..	167 122	18 16	1831 ....
Porthcawl One br., two *red* tide lts.	.....	On ends of breakwater	5a	34	11	1860
Swansea Harbour 1. One *red fixed tide* lt. 2. One fixed bright lt. 3. Two *green* or *red* lts. 4. Two *green* or *red* lts.	51 37. 3 56.	1. White tower on W. pier-head; shown while 8 ft. water. black ball by day .. 2. Additional bright lt. shown 430 yds. from extreme of W. pier, visible only to eastward 3. At South dock, vertically ..... 4. At North dock, horizontally, red when closed, green when open	..	24	9	
Scarweather Sand Lt.-V. One *red* rev. lt., 20 secs.	51 26.9 3 55.1	Off W. end of Sand, in 14 fms. A half globe above usual globe.	●	38	10	1862
Mumbles One bright fixed light	51 34. 3 58.2	A white tower. 56 ft. high, adjoining the fort	a	114	15	1798
Helwick Lightvessel One br. rev. lt. 1 min.	51 31. 4 24.	In 16½ fathoms, off W. end of Sand.	●	38	10	1846
Llanelly Two fixed *Tide* lights	51 40. 4 10.4	One on Whiteford Point (on piles) from ½ flood to ½ ebb; from ½ flood to ¼ ebb on S. end of breakwater	● ..	36 55	7 9	1850 1854
Burry Port One fixed *tide* light	51 41. 4 15.	Near head of W. pier while 10 feet water	●	35	9	....
Saundersfoot, South Pier	.....	One red light or yellow ball while 8 feet.....	..	15	..	....
Tenby Pier Head	.....	One red tide light for steamers, &c.....	..	14	3	1856

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CALDY ISLAND One br. or *red* fixed lt.	51 37.9 4 40.9	The lt. is bright seaward, but is red toward Old Castle Head, from N. 70° W. to N. 56° W., and is red over Woolhouse Shoal from N. 55° E. to N. 15° E.	1a	210	19	1829
MILFORD HAVEN						
ST. ANN'S POINT Two bright fixed lts.	51 40.9 5 10.5	White towers, 75 and 42 ft., 610 ft. apart, on W. side. In one N. by W. ½ W., lead in clear of Crow and Toes Rocks. A red ray from high lighthouse shows over Chapel and Harbour Rocks to between S.E. ¼ S. and E. ¼ S.	● 1a	192 159	19 17	1714 1841
Great Castle Head Two bright fixed lts.	.....	In one, N.E. by E. ⅔ E., lead in mid-channel	.. ..	112 76	.. ..	1870 ....
Pembroke Dockyard	.....	Two red lts. in one lead up. High lt. shown betw. W. by N. ¾ N. & N.W. ¼ N. Low lt. betw. W. by N. ½ N. & N.N.E. A green sector betw. N. ¼ W. and N. by W. ¼ W. is shown over Carr Spit	6a	48	5	1862 1878
Neyland Pier	.....	Bright light near end of landing pier; red lt. occasionally on railway pier	..	..	..	1868
SMALLS One bright (or *red*) fix. light	51 43.3 5 40.1	Granite tower, 141 ft., red & white bands. Lt. bright seaward, from E. ½ S. to S.E. ½ E. The lt. is red over Hats and Barrels Rocks.	1a	125	16	1778 1861
SOUTH BISHOP ROCK One br. rev. lt. 20 secs.	51 51. 5 25.	A white tower, 36 feet high.	1b	144	18	1839
New Quay One bright fixed light	52 12.9 4 21.8	On pier-head. To southward of E. ½ S. the light is red	..	..	..	....
CARDIGAN BAY LT.-V. One rev. *red* lt. 30 secs.	52 24. 5 0.	In 35 fathoms, at 20 miles northward from Port Cardigan	●	40	9	1860 1870
Aberystwith One fixed light *Two bright fixed lights*	52 25. 4 50.	Harbour entrance, lt. red to S. and W., bright to N.W. and N.E. Two lts. in a field, over inner end of harbour, while sufficient water	..	..	..	....
St. Tudwall Roads 1. One br. and *red* lt. 2. One lower *red* lt.	52 47.7 4 28.0	1. Vis. 8 secs., obscured 2 secs. White to westward betw. N. by E. and S. by W. Red from S. by W. to S.E. White from S.E. to N.E. by E. ½ E., and thence red to N. by E. Obscured by East Island, betw. N.E. ½ E. and E. by N. ½ N. 2. A ray with an arc of 15° is shown over Carreg-y-trai, from E. by S. to E. ½ N., from window 16 ft. below main light.	..	151	8	1877
BARDSEY ISLAND One bright fixed light	52 45. 4 47.9	A square white tower, 99 ft. high.	1a	129	17	1821
Llanddwyn Point	.....	A red light all night	●	50	5	1845
Caernarvon	53 8. 4 24.7	One bright light on pier-head	●	..	..	1858
CAERNARVON BAY LT.-VESSEL One rev. light 20 secs.	53 5.8 4 44.2	In 30 fathoms, at 12¾ miles S.S.W. ¾ W. of South Stack light-ho. Flashes bright, bright and red. A small ball over large one.	●	38	10	1869
SOUTH STACK ROCK One br. rev. lt., 1 min.	53 18.4 4 41.9	White tower, 84 ft. During fogs, a smaller br. revol. lt., 1 min., at 90 ft., is shown at 65 yds. W. by S. of lt.-ho., between S. ⅓ W. and N.E. ¾ E.	●	201	19	1809
Holyhead 1. One *red* flash. lt. 7½ s. 2. One bright fixed lt. 3. One small *red* light 4. *Red* and *green* lights	53 18.8 4 37.1	1. Lighthouse on new breakwater. 2. On end of wooden jetty; old harbour 3. On old tower, to N.E., shown from N.E. to N.N.E. ½ E. to clear Platters. 4. Red lt. on starboard; green lt. on port side of inner harbour	.. 6a	66 20	13 ..	1873 1864
SKERRIES One bright fixed light Lower *red* light	53 25.2 4 36.4	Upper lt. not visible over East Platters Rock, from S.S.E. to S.E. ½ S. Red lt. over Ethel and Coal Rocks, from E. ½ S. to E. by N. ¼ N.	1a ..	117 67	15 10	1803 1865

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Amlwch Port One bright fixed light	53 25. 4 20.	On North pier; shown only when the harbour is practicable	●	26	9	1817
LYNUS or ELIAN POINT One intermitting light	53 25. 4 17.3	A white building, 36 ft. high. Light visible 8 secs.; eclipsed 2 secs. Masked to mark Middle Mouse and Dulas Rocks	●	128	16	1835
Beaumaris	.....	Bright light on pier	..	..	..	1865
Menai, Trwyn-Du Point One *red* fixed light	53 18.8 4 2.4	Circular building, 96 ft.	1a	61	10	1837
GREAT ORMES HEAD One fixed light	53 20.5 3 52.	Light bright from N.W. by W. ¾ W. to E., red from E. to E. ¾ S.	1a	213	24	1862
Llandudno	.....	Green light on pier-head. Lower red lt. when it is dangerous to come alongside	..	..	..	....
Rhyl	.....	Bright light on pier-head	..	..	..	....
AIR POINT One br. or *red* fixed lt.	53 21.4 3 19.2	On old lighthouse, with red and white bands. It is red only within Hoyle Sand, from N.W. to E. by S. ¼ S.	●	42	9	1844
LIVERPOOL BAY.						
N.W. LIGHTSHIP One br. rev. lt. ½ min.	53 30.3 3 31.3	In 13 fathoms N.W. ¼ W. 8½ miles from Horse Channel Fairway Buoy; a blue lt. every 2 hours; a black ball.	○	36	10	1814 1873
BAR LIGHTVESSEL One fixed bright lt.	53 32.2 3 17.2	North 9½ miles from Upper Hoylake lt.-ho., & N.W. by W. ¼ W. 8¼ miles from Crosby lt.-ho.	..	..	..	1873
Hoylake Two br. fixed lights	53 23.7 3 10.7	White towers, 55 and 31 ft. In one, S.W. ¾ S., 1,200 ft. apart, near the church	4a ..	55 31	13 11	1763 ....
Leasowe One bright fixed lt.	53 24.8 3 7.5	On the shore, between the Mersey and Dee	●	94	15	1763
BIDSTON One bright fixed lt.	53 24. 3 4.4	A stone tower, 68 ft. high, on the hill; masked to N. by E. ½ E.	●	228	23	1771
ROCK One rev. br. lt. ½ min.	53 26.6 3 2.4	A white tower, 94 ft. high. Also a fixed lt., while 11 ft. down Rock Channel; and another up the Mersey, from same tower.	●	77	14	1830
North Docks Wall One fix. *red* & br. lt.	.....	Bright betw. S. by W. & N. by W. ¾ W., red over Formby Bank E. of N. by W. ¾ W. In line with Rock lt., bearing E. ¼ S., indicates turning point betw. Horse & Rock Channels	..	70	9	1877
Birkenhead New Pier	.....	One bright fixed light	6a	..	..	....
Formby Lightvessel One revolving *red* lt.	53 31.7 3 10.8	At the elbow of Crosby and Queen's Channels, in 50 ft. Hull black.	●	30	8	1834 1863
Crosby Lightvessel Three bright fix. lts.	53 30.7 3 6.9	In 48 ft., off the N.E. elbow of the Burbo Bank; a red ball.	● ..	29 9	8 ..	1840 1869
Crosby Lighthouse One *bright* fixed lt.	53 32.3 3 3.9	Square tower, 74 ft., near the point	●	95	12	1856
Ribble River One intermittent light One *bright Tide Light*	53 44.6 3 1.3	S.E. of Stanner Point; visible 3½ min.; dark ½ min. Tide lt. on new pier, from 2h. before to 1½h. after high water	4b ..	81 ..	12 ..	1848 1865
Lytham Harbour	53 44.2 2 58.5	One fixed light, while the approach is practicable	●	..	..	....
Blackpool Pier	.....	Green light seaward; bright to land	..	..	..	....
Fleetwood Two bright fixed lights	53 55.6 3 0.4	North and South, 850 ft. apart; shown while 9 ft.	● ..	90 30	13 9	1841 ....
Wyre River One bright fixed light	53 57.2 3 1 8	Pile lt.-ho. on N.E. end of North Wharf bank.	..	30	10	1840

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Lune River Two bright fixed lights	53 59. 2 53.	On Cockerham Point and Plover Scar Rock, while 8 ft. water	● ●	54 20	9 ..	1847 ....
Clark Wharf Spit Lt.-Ves. One fixed *red* light	54 1.3 3 0.	Also shows a bright light, while 8 ft.	●	30	5	1854
Morecambe Harbour 1. One fixed bright lt. 2. *Red* and *green* lights 3. Two red lights 4. One *blue* and red lt.	.....	1. At extremity of W. or stone pier..... 2. At pier heads, green to westward, red to northward 3. One 130 yds. from end of stone pier, in line with another 1 cable from end of wooden jetty, lead over ba. 4. Fr m end of promenade pier, blue seaward, red to harbour	..	..	..	....
Morecambe Bay Lt.-Ves. One *red* revolving light	53 54. 3 31.	In 12 fms.; flash ev. ½ min.	●	31	10	1863
WALNEY ISLAND One br. rev. lt., 1 min. One *red* fixed light	54 2.9 3 10.6	On the S. point. In one, N.W. by W. ¾ W., 440 yds. apart. A red light also on Railway Viaduct; and a bright light on Piel Pier ...	●	70	13	1790
Piel Harbour 1. One fixed bright lt. 2. One *red* and br. lt.	.....	1. On Michel Scar 2. Bright to S.S.E. and N.W. in direction of channel	..	..	..	....
Barrow 1. One fixed light 2. One *red* light 3. One flashing lt.	.....	1. On E. side of channel to Barrow, 1 mile N.W. of Piel pier light 2. At dock entrance, 2 hours before to 2 hours after high water 3. From chimney of Hindpool Ironworks, N. of Barrow	..	..	..	....
ST. BEES HEAD One bright fixed light	54 30.8 3 38.	A white tower, 55 ft. high	1a	336	25	1821 1866
Whitehaven 1. One rev. lt. 2 min. 2. *Two fixed lights*	54 33.2 3 35.8	1. A white tower, 37 ft. high, on W. pier-head. 2. Blue lt. on N. pier; red lt. on Old Quay, while 9 ft., in entrance; red flag by day.....	..	52	11	1823
Harrington *Tide Light* One fixed light	54 37. 3 34.	On the pier-head, while 8 ft. water. Red drum while 8 feet	●	44	11	1848
Workington *Tide Lights* 1. Two bright fix. lts. 2. Two green lights	54 39. 3 35.	1. On the ends of St. John's & Wooden piers, E. and W., while 8 ft. water 2. Two green lts. in one E.S.E. lead in	.. ..	53 ..	11 ..	1825 1866
Maryport One br., one *tide light* One *green*, one *red* light	54 43. 3 30.7	Fixed light on outer pier-head. Tide light, while 8 ft., on inner pier. Red light on starboard side, and green light on North Tongue	4a ..	51 ..	12 10	1796 1856
Solway Lightvessel One *red* fixed light	54 48. 3 32.	In 4½ fathoms in Robin Rigg Channel. Black ball.	●	25	6	1841
Lee Scar One bright fixed light	54 51.8 3 24.7	On piles on the rocks.	..	25	6	1841
Skinburness One *red* fixed light	54 52.5 3 23.	A white building, 32 ft. high, on Cott or Silloth Point	..	40	9	1841
Carlisle Port Tide Light	.....	A lamp on the pier-head	..	..	..	1841

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus.	Height above H. W.	Visible in Miles.	Year established.
ISLE OF MAN.						
POINT OF AYRE A rev. lt., br. and *red*, alternately	54 24.9 4 22.	A stone tower, 99 ft. high, ¼ mile S.W. of the point; flash every minute	●	103	15	1818
Peel Harbour One fixed *red* light	54 13. 4 42.9	Red light on East side of entrance. Bright lt. on end of breakwater	● ●	21 32	8 6	1811 1865
One fixed light						
Port Erin One *green* fixed light	.....	On end of new breakwater	..	25	3	1869
CHICKEN ROCK Revolving br. lt. ½ min.	54 2. 4 50.7	Granite tower 143 ft. high, ¾ mile W. from S. extremity of Calf of Man.	lb	122	16	1874
St. Mary Port	.....	One bright light on pier-head	●	25	9	1812
Castletown Harbour	.....	One red lt. on new pier-head. Visible seaward between the entrance points of the bay	..	32	8	1849
LANGNESS One br. flash. lt., 5 secs.	54 3.2 4 37.7	Lt.-ho., 63 ft. high. Lt. shows a flash every 5 secs.	..	76	14	1880
Derby Haven Two bright fixed lights	54 5. 4 36.	On Fort Island (Aug. 12 to Oct. 10); and S.W. end of breakwater	.. ..	50 14	6 2	1850 ....
DOUGLAS One bright fixed light	54 9. 4 28.	A brown stone tower, 65 ft., on Douglas Head; not visible from Lang Ness	..	104	15	1832
Douglas Harbour	.....	One fixed light on the North pier-head	..	34	6	1796
Douglas Bay	.....	A blue light on end of Promenade pier; red light on S. pier-head; green light on new landing pier	..	20	2	1869
Ramsey Harbour	.....	One fixed red light on S. pier-head. One fixed bright light on N. pier-head	● ..	28 34	4 9	1845 1868
BAHAMA BANK LT.-V. One group-flashing br. light	54 20. 4 12.	In 11 fms., on S.W. part of bank. Lt. shows 2 quick flashes, followed by 20 secs. darkness, ev. ½ min.	●	38	10	1848 1879

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
START POINT One fixed *red* light	59 16.6 2 22.4	A new stone tower, on East point of Sanda Island, Ronaldsha Firth	4a	80	14	1806 1870
NORTH RONALDSHA One br. flash. lt. 10 secs.	59 23.2 2 23.6	A brick tower, 139 ft. high, on N. point of Orkney Islands	a	140	18	1854
SHETLAND ISLANDS.						
SUMBURGH HEAD One bright fixed light	59 51. 1 16.	A stone tower, 55 ft. high, on the S. point of Zetland	●	300	22	1812
BRESSAY One rev. lt., 1 min.; red and *white* alternately	60 6.2 1 7.5	White tower, 53 ft. high, on E. side of entrance to Lerwick	2b	105	15	1858
WHALSEY SKERRIES One br. rev. lt., 1 min.	60 25.4 0 44.	A white tower, 98 ft. high, on Bound Skerry...	1b	145	18	1854
NORTH UNST One bright or *red* light	60 51.3 0 53.	A white tower, 64 ft. high, on Muckle Flugga, N. part of island. The lt. is red towards the Skaw of Unst. Red between S.S.E. ½ E., and S.E. by E. ¼ E.	1a	235	21	1854
CAPE WRATH One revol. lt., 1 min.	58 37.5 4 59.7	White tower, 65 ft. high. Flashes white and red alternately	●	400	23	1828 1871
RU STOER One br. intermitting lt.	58 14.2 5 23.	White tower, 47 ft. high, on S. Ear. Visible 1 min. Eclipsed ½ min.	a	195	20	1870
SOUTH RONA One *bright* flash. lt. 12 s.	57 34.5 5 57.4	White tower, 42 ft. high, on N.E. point of island	2c	222	20	1857
Kyle Akin, Loch Alsh One br. or *red* fixed lt.	57 16.6 5 44.5	On S.W. point of Gillean Island. Lt. bright in fairways of Applecross Sound and Loch Alsh. Red elsewhere	a	53	11	1857
Oronsay Island One br. or *red* fixed lt.	57 9. 5 47.	White tower, 63 ft. high, on island, N.W. part of Sleat Sound	4a	58	12	1857
HEBRIDES ISLANDS.						
BUTT OF LEWIS One bright fixed light	58 30.7 6 16.	A white tower, 20 ft. high. Visible seaward from S. by E. ½ E. to W. by S. ½ S.	1a	170	19	1862
Stornoway 1. One br. rev. lt. ½ min. 2. A reflected light	58 11.5 6 22.2	1. White tower, 45 ft. high, on Arnish Point... 2. A prism on beacon, on S.E. end of reef, reflects light from a lower window; visible in entering	2b ..	56 27	12 2	1852 ....
East Loch Tarbert	.....	Red light on breakwater	..	..	..	1876
MONACH ISLES Upper lt., flashing 10. s. Lower lt., fixed *red*	57 31.6 7 41.6	In one tower, 133 ft. high, on Shillay Island. Red lt. shown to northward, from N.W. by N. to N.E. by E.	1a 4a	150 62	17 12	1864 ....
GLASS ISLAND One fixed bright light	57 51.4 6 38.5	White tower, 100 ft. high, on E. pt. of Scalpay, Harris Isles	1a	130	17	1789
USHENISH One fixed *red* light	57 17.9 7 11.5	East side of S. Uist. Shown between N.E. ½ N. and S.S.W.	1a	176	18	1857
BARRA HEAD One intermitting light	56 48. 7 38.	Visible 2½ min., and dark ½ min. On top of Bernera Island	●	680	33	1833
SKERRYVORE One rev. light, 1 min.	56 19.4 7 6.5	Granite tower, 158 ft. high, on the rock	1c	150	18	1844

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H.W.	Visible in Miles.	Year established
DUBH ARTACH ROCKS One fix. bright or *red* lt.	56 8. 6 38.	Tower, 98 ft. high, on rock off Iona Sound. Light is red towards S. coast of Iona and Torranan Rocks, or to between E. ¼ S. and N. by E. ½ E.; the rest bright all round.	1a	145	18	1872
ARDNAMURCHAN One fixed bright light	56 43.6 6 13.5	Stone tower, 118 ft. high, on the point. Shown between N.E. by E. ¾ E., and S.S.W. ½ W.	1a	180	18	1849
Sound of Mull One fixed light	56 38. 6 4.	On Runa Gal Rock. Red lt. N. to seaward; green towards rocks; white towards Mull Sound	4a	55	12	1857
LISMORE One fixed bright light	56 27.3 5 36.3	White tower, 86 ft. high, on Musdile Island ...	●	103	15	1833
Loch Eil One fix. br. or *red* lt.	56 43.3 5 14.5	On Corran Point. Light is red to E., between S.W. by W., and N.E. by E. ⅜ E., and is br. to westward	..	36	10	1860
Oban	.....	A lantern on the pier for steamers	..	..	..	1858
Phladda Island One fix. br. or *red* lt.	56 19. 5 39.5	North end of Scarba Sound. The lt. is red northward, over Bogha Nuadh Rock, betw. N. by E. ¼ E. & N.N.E. ¾ E.; thence bright landward to S.S.W. ½ W.	4a	42	11	1860
Crinan Canal	.....	One red light on East side	..	25	4	1851
Sgeir Maoile or Iron Rock One br. rev. lt. ½ min.	55 52.5 5 49.5	Tower, 83 ft. high, on Sgeir Maoile or Skervuile, at S. entrance to Sound of Jura	2b	73	14	1865 1871
Rudha Mhail One fixed br. or *red* lt.	55 56.1 6 7.5	White tower, 113 ft. high, on N. pt. of Islay Island. Light is red to westward between N.N.E. ½ E. and W. by N. Bright in all other directions	..	..	..	....
M'Arthur's Head One fixed br. or red lt.	55 45.8 6 2.8	White tower, 42 ft. high, on S. end of Islay Island. Light bright up Sound to N. ½ E.; thence red towards Jura to East. The rest bright	1a	128	17	1861
RHYNNS OF ISLAY One flashing lt., 5 secs.	55 40.3 6 30.8	White tower, 96 ft. high, on Oversay Island, off S.W. point of Islay	●	150	17	1825
Lochandail One bright, or *red* fix. lt.	55 44.7 6 22.2	On Dun Point, N. of Port Charlotte. Light is bright to S., from S.W. by W. to S. by W.; thence red to E. ½ S.; then br. to N.E. by E. ¼ E.	4a	50	12	1869
Port Ellen One fixed *red* light	55 36. 6 12.	Square tower, 60 ft. high, on Carraig Fadda Point, West entrance	..	45	11	1853
MULL OF CANTYRE One fixed bright light	55 18.6 5 48.	S.W. headland of Cantyre	●	297	22	1787
SANDA ISLAND One fixed *red* light	55 16.5 5 34.9	On the Ship Rock. Not seen to N. of S.E. by E. ¾ E.; kept in sight, clears Patterson Rk.	1a	165	15	1850
DAVAR ISLAND One br. rev. lt., ½ min.	55 25.7 5 32.2	Stone tower, 65 ft. high, on East part	2b	120	17	1854
Campbellton	.....	Red lt. on old pier-head, shows from S.S.E. to E.N.E.; green lt. on new pier-head, shows from S.S.E. to N.E. by E. ½ E.	..	18	2	....
Ardrishaig	.....	A fixed white light on pier-head	..	25	4	1850
PLADDA ISLAND Two fixed bright lights	55 26. 5 7.1	One 52 ft. above the other. On island, off S.E. pt. of Arran Island. Shown seaward. from N.W. by W. to N.E. by E.	● ●	130 77	17 14	1790 ....

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
FIRTH OF CLYDE.						
Lamlash Harbour One fix. *green* lt., and one fixed *red* light	55 33·3 5 4·0	Lt.-ho. on S.W. end of Holy Id., E. side of S. entr. to harbour. Lts. shown seaward from S.E. ¾ E. to S.W. by S., and in harbour. High lt. green. Fullerton Rock W. ¾ S. 530 yards from lighthouse	4a ..	46 ..	12 ..	1877 1880
CUMBRAE One fixed bright lt.	55 43·3 4 58.	White tower, 36 ft. high, W. side of Little Cumbrae Id.	2a	115	15	1793
Toward One br. rev. lt. 1 m.	55 51·7 4 59·3	White tower, 63 ft. high, on the point	●	55	11	1812
Cloch One fixed bright lt.	55 56.6 4 52.6	White tower, 76 ft. high, on pt.	●	76	..	1707
Greenock, Garvel Point One occulting br. lt.	55 57. 4 45.	Shown from a lt.-ves., in 2 fms., 3⅛ cables N.E. by E. from Garvel house; br. 4 secs., eclipsed twice in next 4 secs.	..	..	..	1879
Two *red*, & one bright light		The red lts., 1 mile N.N.W. of custom-ho., 140 yds. apart. In one, W. by S. ½ S., lead to anchorage. The bright lt. in front of custom-ho.	.. ..	40 26	.. 4	1834 1829
Helensborough	.....	Red lt. on pier-head, green lt. on inner end of pier, between are two bright lights	..	..	..	....
Port Glasgow	.....	One fixed bright lt. off entrance, and another on steam-boat quay	4a	18	3	1861
Cardross	.....	Red light on the Pillar Bank	5a	22	4	1849
Auchenlech	.....	Bright light ⅝ mile above Port Glasgow	..	..	..	....
Bowling Bay	.....	Small light in Forth and Clyde Canal	..	12	2	1849
Garmoyle Lightvessel	.....	Bright light 3 miles above Port Glasgow	..	24	..	1868
Dumbuck	.....	South side of channel	..	..	..	1868
Dickie's Light	.....	Bright light 1 mile above Dumbarton	..	..	..	....
Donald's Quay	.....	Red and bright light	..	26	..	1849
Park Quay	.....	At bend of channel	..	24	..	1869
Near Newshot Island	.....	Red light on North bank	..	24	..	1869
Glasgow, Broomielaw	.....	Gas light	..	22	4	1844
Ardrossan One bright flashing lt.	55 38.4 4 49.5	On breakwater; bright 2 secs.; eclipsed 1 sec. Shown betw. W. and W.S.W.	a	25	5	1840 1870
Saltcoats	55 37·9	Bright bull's-eye in red glass plate, on pier	..	26	6	1840
Troon Harbour Rev. br. lt. & fix. *red* lt.	55 33. 4 41.	Revolves, 40 secs. bright, 20 secs hidden. In one, S.W. ½ S., 350 yards apart	.. ..	35 35	9 6	1827 1848
Ayr Harbour Upper br., lower *red* lt. *Red Tide Light*	55 28.2 4 38.2	At N. side of harbour. Red tide light N.W. by W. ¼ W., 283 yds. distant; while 8 ft. on bar	6a	56 19 14	10 7 5	1790 1826 ....
Turnberry Point One br. flash. lt. 12 secs.	55 19·5 4 50·3	White brick tower, 64 feet high, at ruined castle	b	96	15	1873
Loch Ryan One fixed bright light	54 57·7 5 2.	White tower, 50 ft. high, on Cairn Ryan Point	4a	46	10	1847
Stranraer White, *red* & *green* lts.	54 54·7 5 1·7	On East pier; West pier, and inner end	..	9	..	....
CORSEWALL One *red* and *white* rev. light, 1 min.	55 0.5 5 9.5	A white tower, 110 ft. high, on West side of entrance to Loch Ryan	●	112	15	1817
Port Patrick One fixed bright light	54 50.3 5 7.0	White stone tower, 30 feet high, at S.E. angle of harbour	6a	37	10	1856 1870
MULL OF GALLOWAY One intermitting br. lt.	54 38.1 4 51.3	On S.E. point. Visible ½ min.; invisible ¼ min.	●	325	23	1830
LITTLE ROSS One flash. light, 5 secs.	54 46. 4 5.	White tower, 65 ft. high, on the island	1c	175	18	1843
Annan River **One fixed *white* light**	54 57·7 3 16.	On Barnkirk or Annan Foot, from half flood to half ebb	..	..	..	1841

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
FASTNET One rev. light, 1 min.	51 23.3 9 36.4	Circular white tower, 92 ft. high, with red belt, on the summit of the rock	1b	148	18	1854
GALLEY HEAD One revol. lt. ev. min.	51 31.8 8 57.2	White lt.-ho. on extr. of head. Lt. shows 6 or 7 flashes during 16 secs., and is obscured 44 secs. Visible between W. and E. by S.	c	174	19	1877
KINSALE OLD HEAD One bright or *red* light	51 36.2 8 31.9	A white tower, 100 ft. high, with two red belts. A red ray is sent over the outer part of Courtmacsherry Bay, between N.W. by W. ¼ W. to W. ¾ N., or from the Seven Heads to the Horse Rocks	1a	236	21	1853
Kinsale Harbour One bright fixed light	.....	From window on Fort Charles, on East side.	●	28	10	1804
Daunt's Rock Lt.-Ves. One *red* fixed light	51 43. 8 17.	Vessel black, in 14 fms., at ¾ mile S. by E. from Daunt's Rock, and 4¾ miles S.W. from entrance to Cork Harbour.	●	39	8	1874
CORK HARBOUR						
Roche Point Upper lt. intermit. br. Lower light, fix. br.	51 47.5 8 15.2	White tower, 49 ft. high. Upper lt. shows br. for 15 secs., and is eclipsed 5 secs. Lower br. lt. shows only from S.W. by W. to S.W. ½ S., over Daunt's Rk.	● 2a	98 60	10 8	1817 1864
Queenstown SPIT BANK One fixed *red* light	51 50.7 8 16.4	On piles, in 9 ft. water, on E. elbow of bank. Lt. red, with a sector of br. lt. over Bar Rock, between N.E. by E. ½ E. and N.E. ½ N.	4a	32	8	1848 1853
MEELOUGH SPIT One fixed *red* light	.....	On piles, 100 ft. from the channel.	4a	25	3	1859
Bright, *red*, & *green* lts.	.....	A green lt. is shown on the N. side of the channel at Donkettle; a bright lt. at Black Rock Castle; and a red lt. at Dundain, and also at Tivoli	..	..	..	....
BALLYCOTTIN Flashing light, 10 secs.	51 49.5 7 59.	Circular stone tower, 50 ft. high, on the outer island; shown from E. ½ N. to W. ½ N.	1c	195	18	1850
Youghal 1. One bright fixed lt. 2. Lower *red tide light* 3. Additional *red tide lt.*	51 56.5 7 50.5	1. & 2. In one tower, on W. side of entrance 2. Shown from S.W. by S. to S. by W. ½ W. From 2h. before to 2h. after high water. A tide-ball by day 3. Shown from small building E. of lightho., betw. S.S.E. ½ E. & S.E., from 2h. before to 1½h. after high water	3a	78	6	1852 1870
MINEHEAD Interm. light, 1 min.	51 59.5 7 35.1	On S. side of head. Bright, 50 secs.; suddenly dark, 10 secs. Shown from W. by S. ½ S. to E. ¾ N.	1a	285	21	1850
Dungarvan *Red*, *green*, and br. lt.	52 4.4 7 33.1	On Ballinacourty Pt. Red over Carrickapane Rock; green, over rocks from Ballinacourty Pt., from E. to S.E. by E.; and bright in other directions	3a	52	10	1858
WATERFORD						
HOOK TOWER One bright fixed lt.	52 7.4 6 55.9	Tower, 115 ft. high, striped red and white horizontally, on E. side of entrance.	●	152	16	1859
Dunmore, Pier Head One *red* light	52 9. 6 59.5	West side of entrance. It is bright N. of pier	●	44	5	1826
Duncannon Fort Two fixed lights	52 13.2 6 56.	In one tower. The lower is only seen seaward	● ●	53 43	10 ..	1774 ....
Duncannon N. One fixed light	.....	Half a mile N.N.E. ¼ E. of the fort. In one, with fort lights, lead in	●	128	16	1838
Spit of Passage	.....	One fixed red light, on piles	..	..	..	1867
Rosslare	.....	Ballygerry Bay, Wexford. Bright light on breakwater in progress	..	..	..	....

If a vessel is seen standing into danger, from any of the Irish lightvessels, a gun will be fired as a warning, and the two signal flags J D, of the Commercial Code, hoisted.

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
SALTEES LIGHT-VES. One group-flash. br. lt. 3 flashes once ev. min.	52 2.4 6 40.	By day shows one mast with ball, and jigger mast.	..	38	10	1824 1878
BARRELS ROCK LIGHT-VESSEL One group-flashing *red* light, 30 secs.	52 7.2 6 22.0	Moored 2 miles S. of Barrels Rk., situated S.W. of Carnsore Point. Shows two red flashes in quick succession; a black barrel on the mainmast head. Passing N. of the lt.-ves. is attended with danger	●	38	8	1880
TUSKAR ROCK *Red* and br. rev. light	52 12.1 6 12.3	Circular white tower, 110 ft. high. A flash of 10 secs. ev. min.; bright, bright, and red alternately.	●	101	15	1815
LUCIFER SHOALS LT.-V. One fixed *red* light	52 21.5 6 9.3	In 21 fathoms, 2½ miles E. of shoals; has 3 masts; globe, and light, at main.	o	33	9	1868
BLACKWATER BK. LT.-VESSEL One bright fixed light	52 30.2 6 5.	In 19 fathoms, 3 miles E. ½ S. from black buoy; has 3 masts; 2 globes at main.	o	33	9	1857 1867
ARKLOW BANK S. LT.-VESSEL One br. rev. lt., ½ min.	52 40.8 5 57.2	In 25 fathoms, 2 miles from S. end of bank; has 3 masts; light, and half globe, over globe at main.	●	39	10	1824 1867
ARKLOW BANK N. LT.-VESSEL One group-flashing br. light	52 53. 5 50.3	In 18 fms., 3¼ miles S.E. by E. from N. end of bank. Lt. shows 2 quick flashes, followed by 45 secs. darkness, ev. min. One mast with ball, and jigger mast.	b	38	10	1867 1879
WICKLOW HEAD One bright intermit. lt.	52 57.8 6 0.1	Ten secs. bright; 3 secs. dark	1d	121	16	1818 1867
CODLING BANK LT.-V. One *red* rev. lt. 20 secs.	53 3.6 5 45.4	In 9 fathoms, at 4½ miles S.S.E. ½ E. from S. end of bank; has 3 masts; globe over half globe at main.	●	39	10	1867
DUBLIN BAY						
KISH LIGHTVESSEL One rev. br. lt., 1 min.	53 18.8 5 56.8	In 10 fms., ¾ mile off N. end of Kish Bank.	●	38	10	1811 1865
Kingstown, East Pier One rev. lt., ½ min.	53 18. 6 8.	Tower, 41 ft. high; white and red flashes alternately. Masked N. of S.E. ½ S., to clear Muglin Rocks.	●	41	9	1822
Kingstown, W. Pier	.....	One fixed red light	o	36	2	1845
North Wall, East end	.....	One bright lt. A red ray to S., across river channel	6a	29	..	1820
Poolbeg One bright light	53 20.5 6 9.3	At mouth of River Liffey. Small lower lt. from half flood to half ebb	●	68	12	1768
North Bull Wall One occulting bright light, 14 secs.	.....	Lt.-ho. on extremity, about 330 yds. northwd. of Poolbeg lt.-ho. Lt. shows br. for 10 secs., and is then eclipsed 4 secs.	..	50	10	1880
HOWTH-BAILEY One bright fixed light	53 21.7 6 3.3	White tower, 42 ft. high, on S.E. pt. of Howth Peninsula.	1a	134	15	1671 1813
Howth, East Pier One *red* light	53 24. 6 4.	On pier-head	●	43	11	1818
Balbriggan One bright fixed light	53 36.8 6 11.	White tower, 53 ft. high, on pier, South side of entrance	●	42	10	1769
ROCKABILL One br. and red flash. lt.	53 35.7 6 0.5	Tower, 105 ft. high; flash every 12 secs.; br. seaward, from S. ½ E. to N.E. by N.; red to westward	1b	148	18	1860
Drogheda Two fixed br., 1 *red* lt. One *green*, five br. lts.	53 43. 6 15.	On sandhills, S. of River Boyne. Changeable as sandbank shifts. E. & W. lts. in one, lead in On perches in inner channel	o	..	6	1842

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Dundalk One flash. light, 15 secs.	53 58.7 6 18.	Red screw piles in entrance. Bright lt. seaward from E. to S. ¾ E.; thence masked over Dunany Reefs to S.S.W. ¼ W.; thence red over S.W. banks to N.N.W. ¼ W. Bright lt. to channel, but masked from N. ¼ W. to E., over N.W. sandbanks.	4b	33	9	1855
Eight beacon lights	.....	Between the bar and quay	..	..	..	....
LOUGH CARLINGFORD	54 1.	1. In one tower, 111 ft. high, on Haulbowline Rock. Lower lt. from half flood to half ebb A small red light shown to N.E.	●	101	15	1823
1. Two bright fixed lts.	6 5.		8a	40	6	1873
2. Two br. fixed leading lights		2. Two iron pile lighthouses, ¾ mile N. by W. from No. 1, 500 yards apart. In one N.N.W. ¼ W. lead through new cut in 15 ft.....		23	5	
3. One br. rev. lt. ¾ m.			●	29	9	1830
4. *Red* Pier light			8a	33	5	1873
		3. On Greenore Point				
		4. On Greenore Pier				
DUNDRUM BAY One intermit. *red* light	54 13.1 5 40.	On St. John's Point. Red 45 secs., dark 15 secs. Shaded across the bay to N. of W. by N. ½ N.	1b	62	12	1844 1860
Ardglass Harbour	.....	One fixed red light at its head	●	18	6	1851
SOUTH ROCK LT.-VES. One revol. bright lt.	54 24.7 5 22.3	Supersedes S. Rock lt.-ho., and shows revol. lt. every 1½ min. In 30 fms., 1 mile E. of Ridge Shoal.	..	38	10	1877
Donaghadee One *red* or br. fixed lt.	54 38.6 5 32.	On pier-head. Red to seaward, from S.S.E. to N.E.; br. lt. obscured betw. S. ½ E. & shore	●	56	12	1826
COPELAND One fixed bright light	54 41.7 5 32.	A white tower, 52 ft. high, on Small Copeland Island.	●	131	16	1796
Belfast Bay One Int. lt., and others	54 39. 5 53.	Pile ltho., with int lt., on Hollywood Bank; green lt., also on the Bank; 2 more green lts. towards Belfast; and a red lt. S.W. of Stone Beacon	5 ●	27 ..	5 ..	1848 ....
Larne Lough One fix. bright or *red* lt.	54 51.1 5 47.3	White lt.-ho. on Farres Point. A red sector is shown over reef off Barr Point, and over Hunter Rock, betw. N.E. by E. and N.E. by E. ¾ E. Obscured E. of latter bearing by land	● ..	42 ..	11 9	1839 ....
MAIDENS Two fixed bright lights	54 55 8 5 45.3	Towers, 76 and 68 ft. high, white, with red belt. In one, N.W. by W., 800 yds. apart...	● ●	95 82	14 13	1828 ....
RATHLIN One interm., 1 fixed lt.	55 18.2 6 10.7	Tower, 88 ft. high, with red belt, on Altacarry or N.E. point. Upper lt. intermit., br. 50 secs.; dark, 10 secs. Shown northward, from N.W. ½ N. to S.E. by S., and to S. on Rathlin Island, from S.W. by W. ½ W. to W. ½ S. Red lt. over Carrickvanan Rock. Lower fixed lt. does not show in Rathlin Sound.	1b ..	243 182	21 ..	1856 ....
LOUGH FOYLE						
Inishowen Two fixed bright lts.	53 13.6 6 55.6	E. tower, 49 ft.; W. tower, 74 ft. On Dunagree Point. In one, West, 153 yds. apart. A red sector from W. tower, 25 ft. below br. lt. over Tuns Bank, from E.S.E. to S.E. ½ E.	● ●	67 92	13 15	1837 ....
Warren Point *Red* and bright light	.....	Red to S betw. W. by S. ¼ S. & E. ¼ N.; white seaward from E. ¼ N. towards land, and up Lough Foyle from W. by S. ¼ S. to W. ½ S.	..	..	..	....
Red Castle One fixed bright lt.	.....	On red piles, on outer edge of Ridge Shoal ...	..	25	..	1852
White Castle One fixed bright lt.	.....	On black piles, East side of channel.....	..	26	..	1848
Ture One fixed bright lt.	.....	On black piles, S.E. side of channel.....	..	25	..	1850
Cunnyberry One fixed bright lt.	.....	On red piles, N.W. side of channel	..	25	..	1848
Culmore Point	.....	A lantern on a mast	..	45	..	1848

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
LOUGH FOYLE—(*continued*).						
Culkeeragh	.....	Bright light East side of entrance.....	..	50	..	1851
Boom Hall	.....	One fixed bright light	..	12	..	1859
Rosse Bay	.....	One fixed bright light	..	20	..	1859
Rock Mill	.....	One fixed red light, near the mill	..	15	..	1859
INNISTRAHULL One br. rev. lt., ½ min.	55 25.9 7 13.6	A white tower, 41 ft. high; on N.E. part of island	1b	181	18	1812
LOUGH SWILLEY						
Dunree Head One fixed bright lt.	55 11.8 7 33.2	Shown from a dwelling-house, visible betw. N.N.E. ½ E. and S. ½ E.	●	150	13	1876
Buncrana Pier One small *red* light	.....	From pillar on pier extremity, betw. N. by W. ½ W. and W. by S. ¼ S.	..	..	..	1876
Fannet Point One *red* or bright lt.	55 16.6 7 37.9	Tower, 26 ft. high; light red seaward; bright towards the Lough	●	90	14	1816
TORY ISLAND One fixed bright light	55 16.4 8 15.	White tower, 87 ft. high, on the N.W. point of island. Obscured by island to S.S.E.	1a	125	16	1832
ARANMORE ISLAND One rev. *red* and br. lt. Lower *red* light	55 0.9 8 33.6	Tower, 76 ft. high, on Rinawros Pt. Lt. shows altern. red & br. flashes (of equal intensity) ev. 20 secs. Lower lt. red to eastward over Stag Rocks, betw. N.E. by E. ¼ E. & E. by N.	1b	233 200	25 ..	1865 1871
RATHLIN-O-BIRNE One fixed br. or *red* lt.	54 39.8 8 49.9	Tower, 65 ft. high, on W. side. Lt. is bright seaward from N.E. ½ N. to S.S.E. ½ E. Red towards mainland and sound.....	●	116	16	1864
Killybegs St. John's Point	54 34.1 8 27.6	White tower, 47 ft. high. One bright fixed lt.	●	98	14	1831
Rotten Island	.....	One br. fix. lt., with red sector, over Bullockmore Rk., betw. S.W. ¾ S. & S.W. by W. ¾ W.	●	66	12	1838
SLIGO						
Black Rock	54 18. 8 37.	One fixed bright light in the bay	●	79	13	1835
Oyster Island	.....	Two fixed bright lights; in one, S.S.E. ¾ E. ...	●	40	11	1837
Killala Bay One fixed *red* light	54 13.9 9 11.8	Shown from a window in the tower of Ross Coastguard Station, betw. E. by N. ½ N. and E. by S. ⅛ S., through E.	..	..	..	1880
Broadhaven One br. or *red* fixed lt.	54 16. 9 53.	On Gubacashel Point. White to seaward; red towards West side of harbour.....	3a	87	12	1855
EAGLE ISLAND Two bright fixed lights	54 17. 10 5.5	White towers, 87 and 64 ft. high. In one, E. by N. and W. by S., 132 yds. apart, clears all rocks off Black Sod Bay and Broadhaven	●	220	20	....
BLACK ROCK One flashing lt., ½ min.	54 4.2 10 19.3	Tower, 50 ft. high, on W. extremity of Black Rock; red toward land, from N.E. by E. ¼ E. to S.E. by E. ½ E.	1a	283	22	1864
Black Sod Quay One fixed br. or *red* lt.	54 5.9 10 3.6	On Blacksod Point. Light bright, but red between S.W. by W. and S.W. ¾ S.	3a	37	10	1866
CLEW BAY.						
CLARE ISLAND One fixed bright light	53 49.5 9 59.5	On North Point	●	341	27	1806
Inishgort Island	.....	One fixed bright light	●	36	10	1827
SLYNE HEAD One rev. light, 2 min. One fixed bright lt.	53 23.9 10 14.	On Illaunimmul Island. N. light-tower, 79 ft. high. Lt. rev.; once red, and twice bright. S. light-tower, 79 ft. high; fixed light. In one, N. ¾ E., 142 yds. apart, lead outside of rocks	● ..	126 115	15 14	1836 ....

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
GALWAY BAY.						
EERAGH ISLAND One rev. br. lt., 1 m.	53 8.9 9 51.5	Tower, 101 ft. high, white, with red belts, on West point	1b	115	16	1857
Straw Island One fixed *red* light	53 6.9 9 37.8	Shown betw. W. by N. ¼ N. & S.E. Vis. from inside Arran Isles. Buildings white	..	30	6	1878
Inisheer One bright or *red* lt.	53 2.7 9 31.5	Tower, 112 ft. high, with broad red belt, on S. pt. Lt. is red in direction of Finnis Rock...	1a	110	15	1857
Mutton Island One fixed bright lt.	53 15.2 9 3.1	On centre of island, off Galway	..	33	10	1817
SHANNON RIVER.						
LOOP HEAD One intermit. br. lt.	52 33.6 9 55.9	White tower, 75 ft. high, 500 yds. from extr. of head. Lt. bright 20 secs., eclipsed 4 secs. Shown from N.E. by E. ½ E. to S.E. by E....	1a	277	22	1853
Kilcradan One bright or *red* lt.	52 34.8 9 42.6	On the point. Red to seaward; bright to river	●	133	16	1824
Scattery Island One fix. br. or *red* lt.	.....	Tower on S. end of island, River Shannon. Lt. is red over Rinana Shoal, between N.N.E. and N.E. by E. ½ E. Bright light eclipsed landward between N.E. ¾ E. and N.W. by W. ½ W.	5a	50	10	....
Tarbert One bright fixed lt.	52 35.5 9 21.8	On the rock	3a	58	13	1834
Beeves Rocks One bright or *red* lt.	52 39. 9 1.3	Red to N. of rock. Sixteen small lights below Limerick	3a	40	10	1854
Tralee One bright or *red* light	52 16.2 9 52.9	On Little Samphire Island. Br. lt. seaward, from N. ¼ W. to W. by N. ½ N., and red over anchorage from W. by N. ⅛ N. to E. by S. ⅛ S.	4a	56	9	1850
TEARAGHT ISLAND Light revolving 1½ min.	52 4.5 10 40.	Lighthouse, 57 ft. high. Lt. shown between S. ¾ E. to E. by N. ¾ N.	1b	275	22	....
Valentia One fixed bright light	51 56. 10 19.3	White tower, 48 ft. high, on Cromwell's Fort	●	54	12	1841
SKELLIGS One fixed bright light	51 46.2 10 32.7	On highest rock, 7½ miles from shore. Lt. shown from lower tower, only visible to the southward between N.W. ½ N. and E. by S. ½ S. Upper tower not lighted	◎	175	18	1826
CALF ROCK One br. flash. lt. 15 secs.	51 34.2 10 14.8	Tower red, with white belt, 102 ft. high	1b	141	17	1866
Bantry Bay One fixed bright light	51 39.2 9 44.8	White tower, 62 ft., with red belt, at East entrance to Bearhaven. Light shown from E. ¾ S. to N.W. by W. ¾ W.	●	55	12	1847
Crookhaven One bright or *red* light	51 28.6 9 42.6	On Rock Island Point. Tower, 112 ft. high, with broad red belt, on S. point. Lt. red across rocks to Streek Head, from S. ⅛ W. to S.E. by E. Bright to southward	3a	67	13	1860
FASTNET ROCK One rev. light, 1 min.	51 23.3 9 36.4	Circular white tower, 92 ft. high, with red belt, on the summit of the rock	1b	148	18	1854

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
SWIATOI NOSS One fixed bright light	68 8.8 39 47.7	Light yellow tower; a beacon tower near.....	●	298	20	1863
Sosnovets Island One fixed bright light	66 29.3 40 43.4	Light yellow tower, 82 ft. high	●	139	13	1863
ARKHANGEL GULF One fixed & flashing lt. every 30 secs.	65 28.2 39 44.3	Octagonal yellow lt.-ho., of wood, on Zimnia Hills, right bank of Kammeni River. Visible from N. 27° E. to S. 21½° E.	●	349	20	1878
JIJGINSK One fixed bright light	65 12.3 36 51.5	Tower, 58 ft. high, on the N. height of island	●	140	17	1842
MOUDIUGA 1. One fixed bright lt. 2. Two fix. leading lts.	64 54.8 40 17. 64 51. 40 19.7	1. On a sandy hillock on W. side of island ... 2. At S. end of Moudiuga Id. Southern lt. from black tower, 57 ft. high, shown from S. by E. ⅛ E., by the W., to N.W. ¼ N. Northern lt. is red, shown betw. N.W. ⅜ W. & N.W. ⅛ N. from white tower, 13 ft. high, 470 yds. N.W. of former. Lts. in line S.E. lead over Beresov Bar	● 4a 6a	140 66 20	16 9 5	.... 1875 1875
Bol Shoujmuia Island One bright fixed light	64 40.2 35 35.5	Yellow tower, 76 ft. high, on island in Gulf of Onega.....	●	146	12	1871
Solovetski One fixed bright light	65 7. 35 37.5	From upper part of church on Sekirnoi Hill...	●	410	20	1863
Morjovets One fixed bright light	66 45.9 42 30.	540 yds. in-shore of N.W. point of island	●	150	14	1842
ORLOV One fixed bright light	67 11.2 41 20.5	Stone tower, 64 ft. high, on N.E. point of Cape Orlov, 1,200 yds. from the beach. Arkhangel pilots.....	●	222	17	1842
ICELAND						
Reykjanes Point One fixed bright lt.	63 48.2 22 41.3	On S.W. extr. of Iceland. Shown from Aug. 1st. to May 15th.....	●	180	19	1879
NORWAY (West Coast).						
FRUHOLM One bright fixed light	71 5.8 23 59.4	Red iron tower, 38 feet high, with white belt, near Ingö .. Aug. 25 to March 31.....	1a	148	20	1866
Hammerfest One fixed bright light	70 40.2 23 40.	On extreme point of Fuglenæs. Aug. 25th to April 19th	6a	30	11	1859
Hekkingen One bright fixed light	69 36. 17 50.5	Yellow wooden lt.-ho., 24 ft. high, N. side of Hekking Id., Malang Fiord. Lt. shown from N. by W. ⅜ W., through E., to S.S.E. (Aug. 15th to May 1st)	4a	66	11	1859
ANDENÆS One fix. and flashing lt.	69 19.5 16 9.	Iron tower, red, 114 ft. high. Flash every 3 minutes. August 15th to May 1st	2d	143	20	1859
Lodingens Harbour One fixed bright light	68 24.5 16 3.	On East side of Hjertholm	6a	67	10	1862
Stangholm One bright fixed light	68 10.6 15 38.	Near Tranö-Vest Fiord.....	4a	42	11	1864
LOFOTEN ISLANDS.—(Lights not shown in summer, May 1st to August 15th.)						
Kjeöen, South Point	68 13.2	One fixed red light on Svolvær	●	54	4	1856
Orsvaag Harbour	68 11.7	One fixed bright lt. on N.E. side of Sagoen Id.	●	92	6	1862
Sjaaholmen	68 9.5	One fixed red light at Skraaven's Harbour ...	..	31	4	1856
Stamsund	68 7.2	Tornholm, South point. Keep the lt. in sight, to avoid the Stabben Rock	●	56	7	1859
HENNINGSVÆR One fixed & flash. lt.	68 8.5 14 14.0	Quitverden, in Salvorings Sound. Flash every 3 minutes	●	113	16	1857
Svinö	68 2.8	One fixed red light near Balstad	6a	196	8	1857
Reine Harbour	67 55.8	One fix. bright lt. on S. pt. of Olenilsoens Id.	..	41	6	1862
Klopen, or Gloppen One fixed bright lt.	67 53.5 13 4.	Lt.-ho., 23 ft. high, at Sörvaagen, S. of entr. Lt. shown from W.S.W. (through S.) to N.E. ¾ N., except where obscured by land betw. W.S.W. and S.W. ½ W.....	3a	134	18	1857
Vœrö One fixed bright lt.	67 39. 12 45.3	White concrete lt.-ho., 36 ft. high, on E. side of Röstnœsvaagen. Lt. shown from N.E. ¼ E. to W. ¾ S. (Shown from Sept. 1 to April 14)	6a	31	8	1880
Vaagö, or N. Hellig Vær.	67 26.	One fixed red light on N.E. point of island ...	5a	45	12	1859
Grytö, or S. Hellig Vær.	67 23.3	One fixed bright light on S.E. point	3a	106	17	1865
Nyholm Island One fix. white & *red* lt.	67 17. 14 24.	Stone tower on E. pt. of Id. Lt. shown from Aug. 15 to April 30. In W. channel, white betw. S.W. by W. ½ W. & W. by S.; red from W. by S. to W. In N. channel, white from N. by E. ½ E. to N.E. ¼ N.	6a	62	8	1876

Name and Character of Light.	Lat. N. Long. E. ° ′	Description. &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
STÖT One fixed & flashing lt.	66 56.6 13 28.9	On centre Seskiær; guide to the harbour from the North. Flash every 2 minutes	4c	49	12	1867
TRAE ISLANDS Revol. br. lt. ev. min.	66 25.8 11 59.8	Iron lt.-ho., painted red, on Söe Id. Lt. vis. 12 secs. in ev. min. Shown from Aug. 15 to April 30 following	2b	119	17	1877
ANDERSBAK ISLAND One fixed *red* and br. lt.	66 15.8 12 19.	White concrete lt.-ho. on N.E. Id. of Aas Vær Group. Lt. shows br. betw. W. by N. ¼ N., through North, to E. by S. ¾ S.; thence red to S.E. by E. ½ E.; and thence bright to S. by W. ¼ W. (Aug. 15 to April 30)	4a	50	11	1877
Brönösund One fixed bright light	65 28.5 12 13.5	On North side of Buholmen, at N. entrance...	6a	42	10	1862
Præstö One fixed bright light	64 47.4 11 7.8	On the islet, in Folden Fiord. August 1st to May 16th	6a	36	12	1841
GJOESLINGERNES One fixed *red* and br. lt.	64 43.8 10 51.5	White stone tower on Haroldsö Kraaka Rock. Lt. shows br. seaward betw. W. by S. and S. by W. ¾ W.; red thence to S.S.E. ¾ E.; bright thence to E. ½ N.; and red thence to E. by N. ½ N. (Aug. 15 to April 30)	4a	72	11	1877
VILLA One fixed and flash. lt.	64 32.8 10 41.9	On the island. A flash every 4 min. Aug. 1 to May 16. Pilot station near	2d	127	20	1859
Rödö One fixed bright light	64 22.5 10 27.4	On highest point of island. Aug. 1 to May 15	4a	278	16	1864
HALTEN ISLAND One flash. lt. ev. 4 secs.	64 10. 9 27.5	White stone tower. Lt. shown from Aug. 1 to May 15	2c	127	17	1875
Kjeungen Rock One fix. *red* or br. lt.	63 43.7 9 35.3	Approach to Bingn Fiord. Octagonal red lt.-ho., 57 ft. high. Lt. is bright betw. S. 41° W. and S. 36° W.; red thence to S. 30° W.; bright betw. S. 13° W. and N. 86° E.; red thence to N. 30° E.; bright thence to N. 77° W. (Aug. 1 to May 15)	4a	46	11	1880
Trondhjem One fixed bright light	63 27.5 10 27.5	On the fortress, on Munk Holm, opposite the town. Aug. 1 to May 16	6a	44	18	1840
Agdenäs One fixed bright light	63 38. 9 49.5	On the pt. Visible int and out of Trondhjem Fiord. Aug. 1 to May 16	..	116	9	1831
Börö One fix. white or red lt.	63 44.2 9 18.	At East end of Hitteren Island, entrance of Skiören Fiord; red sector between N.E. and N.N.E. over Sles Skär	5a	48	9	1874
Terningen One fixed bright light	63 30. 9 9.	On the island. Aug. 1 to May 16	5a	100	12	1849
Ringholm Rock One fixed bright light	63 19.3 8 14.5	Yellow wood tower, 30 ft. high, half a mile from E. point of Eddo. Aug. 1 to May 16...	5a	51	14	1849
CHRISTIANSUND						
Stavnæs One fixed bright lt.	63 6.8 7 40.2	On N.E. point of Averö. Aug. 1 to May 16	5a	65	12	1842
Leervig One fixed bright lt.	63 6.3 7 43.5	On North side of island. Aug. 1 to May 16 ...	..	..	..	1863
KVITNŒS One fix. br. or *red* lt.	63 7.9 7 48.8	Wooden tower, painted white, on extr. of pt., at entr of N. channel to Christiansund. Lt. shows red betw. W.S.W. and N.W. by N. leading N. of Haask Rock; white from N.W. by N. to N. by E. ¾ E., leading 3 cables W. of Golmodden; and red from N. by E. ¾ E. to E.S.E. (Aug. 1 to May 15)	5a	60	9	1877
Hest Islet One fix. *red* or br. lt., or flashing br. lt., 2 secs.	63 5. 7 30.	White square tower. Lt. shown betw. W. by S. and E. by N. ½ N., fix. br. over the Ravngab and other navigable channels, and flashing br. (short eclipses ev. altern. sec.), or fix. red, over dangerous ground	3a	75	15	1879
QVITHOLM One fixed and flash. lt.	63 1.3 7 14.5	Stone tower, 96 ft. high, on N.W. pt. of island. A flash of 12 secs. every minute	2c	134	19	1842
Biorno Sound One bright fixed light	62 53.9 6 49.3	On the eastern part of Moöen	5a	94	11	1871
OHNA One br. lt., *red* flash	62 51.8 6 33.	Red iron tower, 40 feet high, on Ohna Calf. Red flash every ½ min.	2c	143	18	1867
Ulla One fixed bright light	62 41.2 6 10.2	Fishing lt. on Kværnholm, S.W. of Ullaholm; from Jan. 25th to April 8th	6a	65	8	1874

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Lepsörev One fixed bright or *red* light	62 35.4 6 15.5	White lt.-ho. on head of Gamlemshaug Mole. Lt. br. from W.S.W., through W. & N., to N.E. ½ N., red betw. N.E. ½ N. & N.E. by E. ¼ E., & br. betw. N.E. by E. ¼ E. & E.N.E. From Aug. 1 to May 31.	4a	28	9	1879
Erkna Island	62 33.3	Red light, spring fishery light	6a	160	11	1870
Synæs, Wiggeren Island	62 32.5	Bright fixed light, spring fishery light	6a	30	9	1870
Walderhoug One fixed *red* light	62 30.1 6 7.4	On South point of Walderö. Aug. 1 to May 16	●	41	4	1860
Aalesunds	62 28.7	One red fixed light on Moloen Point	●	12	5	1863
Alnæs, Godö Island	62 30.	Bright fixed light, spring fishery light	6a	30	9	1870
Hogsten One fixed and flash. lt.	62 28. 6 1.5	Flash every 3 min. On S.E. of Godö Island, Bred Sound	4d	41	12	....
RUNDÖ One fixed bright light	62 25. 5 35.1	Iron tower, 98 ft. high, white, with red belt, on W. point of island, Bred Sound. Aug. 1 to May 16	1a	161	22	1858
Flæevär One fix. or changing lt.	62 18.8 5 36.5	Bright lt., except towards Skiäggen, when it changes to red every 3 secs.	●	56	12	1870
Frekö Island One fix. br. and *red* lt.	62 10.5 5 22.7	Bright lt. from white tower, vis. betw. N. by W. ¾ W. and E. by N. ½ N., but red from N.W. ½ N. to N.W. by W., and from E. ¾ S. to E. ¼ N. From Aug. 1 to May 15	..	68	11	1876
Wägsö One fixed *red* light	62 2. 5 7.8	On Skog Näs, N.E. point of island. Over Kræka and Melflua Shoals; or from N. by W. ½ W. to N.N.W. ½ W., it is eclipsed every 2 or 3 secs. From Aug. 1 to May 15	..	57	12	1870
Hjertnesstrand One bright fixed light	61 59. 5 10.	Yellow wooden lt.-ho., 33 ft. high, on E. side of Ulve Sound. Lt. shown betw. N. ¼ E. & E.N.E., also betw. N. by W. and W. by N. ½ N. over Skare Bay anchorage	6a	58	10	1870
Smörhavn One *red* or bright light	61 45. 4 55.	On Froesoen. Lt. red from N.N.W. ¾ W. to N.W. ½ N.; thence bright to E. ¾ S.	3a	..	..	1871
Stabben One fixed light	61 36. 4 57.6	Bright lt.; red towards Florö from E. ½ S. ...	5a	50	12	1867
Kind Island One bright fixed light	61 33.6 4 46.7	On S.E. part. Shown eastward between N. by E. to S. by W.	6a	33	10	1867
Ronglevär One fixed br. or *red* lt.	60 48. 4 48.	On Bratholm. Bright seaward, but red to S. channel, or from S. ¾ W. to S.S.W.	6a	53	10	1870
HELLISÖ One br. rev. lt., 1 min.	60 45.1 4 43.1	Iron tower, 100 ft. high, red, with white belt. Beyond 8 miles it is dark between flashes ...	2b	154	19	1855
SKIÆLLANGER One fixed bright light	60 36.6 4 57.2	N.W. side of Holzenö Island. Guide to N. channel to Bergen. July 15 to May 16	5a	58	13	1853
Bergen One fixed *red* light	60 24. 5 18.3	On mole. Guide to Vaagen and chief anchorages. Aug. 15 to April 30	●	41	4	1839
Leeröen One fixed bright light	60 14.3 5 10.3	West side of island. Shown westward, from S. by W. to N.E. ½ N. Obscured over Rougnene. July 15 to May 16	●	57	4	1855
MARSTENEN ROCK One revolving *red* light	60 7.8 5 1.	Stone tower on highest part of Id., at Kors Fiord entr. Flash of 8 secs. every 20 secs....	b	120	17	1877
Piir Holm One fixed bright light	60 5.2 5 11.5	Bagholm Sound. July 15 to May 16	●	32	4	1849
Öxhammer One fixed bright light	59 59.3 5 13.7	East side of Selbö. Eclipsed in direction of Nyleden over an arc of 17°. July 15 to May 16	●	130	4	1860

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
SLOTTERÖ One fixed bright light	59 54.5 5 4.5	Iron tower, 72 ft. high, red, with white belt, on N.W. pt. of islet. S. entrance to Selbö Fiord	2a	152	18	1859
Kingholmen Island One fixed bright light	59 53.2 5 13.3	Lt.-ho. on W. end of id. Lt. vis. from N. ¾ W., clearing Tranö Id. to S. ¾ E. From July 15 to May 15	4a	30	10	1876
Folgeröen One fixed bright light	59 48. 5 18.7	On island at Stoksund. July 15 to May 16 ...	●	51	4	1855
Leervig One fixed bright light	59 46.8 5 32.9	S.E. coast of Stordöen Id. From gable of white dwelling on S. pt. of Midtö Islet. Lt. shown betw. S.W. by W. and N.N.E. July 15 to May 15 following	5a	49	9	1878
Midtholmen One fixed *red* light	59 42. 5 24.2	Mosterhavn. Shown eastward, from N.N.E. to S.W. by W. July 15 to May 16	●	39	4	1855
Langevaad One fixed bright light	59 36.7 5 15.2	Lille Blegen. East side of Bommelö Island. July 15 to May 16	●	16	3	1855
Espevär One fixed bright light	59 35.1 5 9.3	S. entrance of harbour. Oct. 1 to April 1	●	75	6	1849
Ryvarden One bright fixed light	59 31.7 5 13.6	On point leading into Bommel Fiord. July 15 to May 16	●	63	6	1849
Roesar One fixed bright light	59 26.1 5 7.6	On Gitterö Rock, East side of entrance. Shown eastward, from N. ¾ E. to W. by S. ¾ S	●	92	6	1860
Särhoug One fixed bright light	59 25.2 5 14.7	On rock at N. entrance of Karmö Sound	5a	72	12	1846
Höievarde One fixed bright light	59 19.5 5 19.5	East side of Karmö	●	66	6	1858
Fæö One fixed light	59 22.7 5 10.7	Bright lt., but is red over Gangvar Rock	..	45	9	1871
UDSIRE Two fixed bright lights	59 18.3 4 52.7	Two red stone towers, 40 ft. high, on W. side of island. N.W. and S.E., 220 yards apart, throughout the year	2a	255	21	1844
Kobbervig One fixed red light	59 17.2 5 19.7	On E. side of Karmö; on N. side of entrance...	●	31	3	1863
Bukke Sund One fixed bright light	59 13.4 5 27.6	E. side of Bukken Island. Oct. 1 to April 1...	●	..	4	1849
Skudes Ness Havn	.....	One fixed bright light. Oct. 1 to April 1	..	..	4	1849
Skude Ness One fixed bright light	59 8.4 5 18.	S.E. point of Karmö. Kept in sight, clears the Ostboen. Oct. 1 to April 1	●	77	6	1799 1840
Vigholmen One bright *red* light	59 8.4 5 16.8	On islet, off Skudes Ness Harbour; must be kept in sight, on the port hand, when approaching	●	..	4	1849
Fieldö One bright fixed light	59 5.3 5 34.4	On Vindhoug, Klubben Islet, North side of channel to Stavanger. July 15 to May 15 ...	●	..	6	1849
HVIDINGSÖ One fixed and flash. lt.	59 3.7 5 24.4	White stone tower, 85 ft. high. Bright flash, every 4 min., throughout the year	2d	149	21	1700 1853
Dusevig One bright fixed light	58 59.8 5 41.3	On Varnæs, S. point of bay. For pilots' use...	●	..	6	1865
Stavanger One bright fixed light	55 58.2 5 44.3	On Valberg tower. Sept. 15 to March 15	●	..	4	1862

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Tunge Ness One bright fixed light	59 2.1 5 34.2	On S. part of Bukke Fiord; on West side of channel to Stavanger. July 15 to May 15...	6a	31	10	1828
Fladholmen One fixed bright light	58 55.3 5 33.7	On N.W. point; eastward of Rot.....	6a	43	10	1862
Lille Feisteen One fixed *red* light	58 49.5 5 30.9	On S.E. pt. of islet, at 4½ miles N.E. from Joederens Point. All the year	4a	68	12	1859
Obrestadbrækka One fix. & flash. lt. ½ m.	58 39.5 5 33.5	On gable of stone-house; lt. obscured to S. to ½ mile from land off pt. near Haa. Life-boat	3c	109	16	1873
EGERÖ One fixed bright light	58 26 5 52.2	Iron tower, 105 ft. high, red. with white belt, on W. point of island. Throughout the year	1a	154	24	1854
Grundsund Holm One fixed br. light	58 27.8 5 53.1	On N.W. point of island, on S. side of channel S. of Egerö. Throughout the year.....	5a	43	11	1855
Vibberodden One fixed br. light	58 25.3 5 59 6	S.E. point of Egerö, West side of Egersund...	5a	73	12	1855
Varnäs One fixed bright light	58 10.6 6 37.3	South point of entrance to Lister Fiord.....	5a	90	12	1836
LISTER One br. flash. lt. 4 secs.	58 6.5 6 34.2	One flashing lt. every 4 secs., instead of three fixed lights on Gunnarshoug, West point of Lister Land. Throughout the year.	2a	130	19	1853
South Katland Islet One fixed *red* or br. lt.	58 3.5 6 50.6	Farsund Channel. Shown from wh. bldng. at S. e. pt. of islet, br. seaward between N.W. and S., red betw. S. and S.S.E. ¼ E., & br. from S.S.E. ¼ E. to E. Also br. to northwd. betw. N.W. by W. ½ W. and N. ½ E., and towards Faerokalven betw. W. and W. ½ N. At N. extr. of Faerokalven a reflector is placed to reflect a sector of 12° of light towards E.N.E.	4a	51	10	1878
NAZE OF NORWAY, or LINDESNÆS One fixed and flash. lt.	57 59. 7 3.	White and red tower, 33 ft. high. Flash every minute. Throughout the year	1d	164	24	1853
Mandals Ryvingen One bright lt., *red* flash	57 58.1 7 29.7	On S.W. part of Ryvingen; red flash every half minute.....	3d	135	18	1867
Hatholm One bright fixed light	58 0.2 7 27.2	On S. point of island, in Manne Fiord	6a	64	10	1867
CHRISTIANSAND FIORD **Odderö** One fixed bright lt.	58 8.2 8 0 5	On S.W. point of island	..	27	10	1832
OXÖ One fixed bright lt.	58 4 4 8 3.6	Round white tower, 92 ft. high, on S. pt. of island, entrance of Christiansand Fiord	2a	139	19	1853
Gronningen Islet One fixed *red* light	58 5.1 8 5 8	Christiansand Fiord, E. side of entr. White building on summit of islet. Light shown westward between S.E. and N.N.W.	4a	50	9	1878
Store-Grönningen Island One fix. & flash. br. lt.	58 15.3 8 32.2	White lt.-ho., on S.W. extr. of Id., E. of Homborgö. Lt. fix. for 30 secs., followed by 4 flashes occupying 30 secs.	3c	71	15	1879
Ärendal One fixed bright light	58 26.3 8 47.4	Yellow building on Sandvig Point, W. side of channel. The lt. is red to W. of S. ½ E. ...	6a	43	11	1844
TORUNGEN ISLANDS Two fixed bright lights	58 24 1 8 47.7	On Outer Torungen and Inner Torungen, N.N.E., 1,200 yards apart	2a 2a	134 134	20 20	1844 ....
Kjeholmen One fix. & flash. *red* lt.	58 38.3 9 9.5	White lt.-ho. on S.W. extr., N.E. of Lyngö. Red flash every alternate minute	3c	68	10	1879
Stangholmen Island One fixed *red* light	58 42.7 9 15.	Yellow building on East point. Light shown from N. ¾ E. by N. and E. to S. ¾ W.	5a	34	10	1855
Kills Fiord Two *red* fixed lights	.....	One on Stafseng; one on Strömtangen, nr. Rabbet Pt. In one, lead through Stangbo Chan.	5a 6a	80 25	7 6	1874 1874

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
DUNKERQUE	51 3.	1. Brick tower, 177 ft. high, between W. jetty	1b	194	24	....
1. One rev. br. lt., 1 m.	2 21.8	and Risbon old fort. Lifeboat station	●	85	12	1845
2. One bright fixed lt.		2. On Heuguenar tower, at 2,400 yds. S. by	5	33	9	1878
3. One tidal light		E. ¾ E from entrance; shows only in the	4	26	3	1863
4. One fixed *green* lt.		channel to N. by W. ½ W.				
		3. Lt.-ho. wh., 27 ft. high, 49 ft. within extr. of W. mole. Tide at less than 6½ ft. above low water, & falling, lt. shows green, rising red. Tide over 6½ ft. above low water, & rising lt. shows white, varied by flashes.				
		4. On East jetty head				
DUNKERQUE ROAD.						
Out Ruytingen Lt.-Ves.	51 12.9	Painted red. In 8 to 11 fathoms. Bears	●	33	11	1863
One rev. *red* lt., ½ m.	2 12.2	N. by W. ¼ W. 11¼ miles from Dunkerque lighthouse.....				
Dyck Lightvessel	51 3.1	In 11 fathoms, at 3½ miles N. by W. ½ W. from	●	34	10	1869
Two bright fixed lts.	2 3.5	Gravelines lighthouse	..	23	..	....
Snouw Lightvessel	51 3.5	In 11 fathoms, at 5 miles E.N.E. from Grave-	●	33	7	1869
One fixed *red* light	2 12.6	lines lighthouse				
GRAVELINES	51 0.3	1. Tower, 89 ft. high, on Little Fort Philippe.	3a	95	15	1843
1. One fixed bright lt.	2 6.5	2. Tide lts., 65 yds. apart, on S.W. mole, from	●	20	6	1854
2. *Two* bright fixed lts.		2h. before to 2h. after high water. Life-				
		boat station.....				
Walde Point	50 59.7	Iron beacon, 59 ft. high, on edge of sands.....	3b	34	10	1869
Flash. lt., *red* & br. fl.	1 55.1					
alternately ev. 20 s.						
CALAIS	50 57.7	Flash every 4 minutes. Octagonal brick tower,	1d	190	20	1848
One fixed and flash. lt.	1 51.2	167 ft. high, at N.E. end of old fortifications				
Calais Tide Lights						
1. One br. fix. lt., &	.....	1. On end of E. jetty; br. lt. 10 ft.; red below	4a	39	10	....
two *red* lights		br. lt., 13 ft.; red above br. lt., 16 ft.; three				
2. One *red* light		lts., 20 ft.				
		2. On end of W. jetty; all night. Lifeboat station				
CAPE GRISNEZ	50 52.2	Tower, 79 ft. high, ¼ mile S. of cape. A	1b	226	25	1842
One rev. br. lt., ½ min.	1 34.9	powerful MAGNETO-ELECTRIC light.....				1869
Boulogne *Tide Lights*	50 43.9	1. In one tower, on S.W. jetty head; higher lt.	4a	43	9	1835
1. Two fixed bright lts.	1 35.1	while 9½ ft.; lower lt., from high water to 9	..	33	.	....
2. One *red*, one *green* lt.		feet ebb. Lifeboat.	4a	46	7	....
		2. On N.E jetty. Green lt. while 9½ ft. water. In line with red lt. indicates direction of stone foundation of the jetty. Life-boat station...				
ALPRECK POINT	50 41.9	A bright lt., with red flash every 2 min. Tower,	4d	161	12	1842
One fixed and flash. lt.	1 33.7	33 ft. high, 2¼ miles S.W. of Boulogne				
CANCHE or Etaples River						
Carniers Sandhills	50 33.1	Shown from white towers on N. side of river;	●	121	10	1874
Two fixed lights	1 36.8	when in line, bear E. northerly; formerly	●	54	9	1874
		served as leading lts. Lower lt. is red. In line, lead over Touquet Bank.....				
Point Touquet	50 31.4	Two fine brick towers, 171 ft. high, at S. side	1a	174	20	1852
Two fixed bright lts.	1 35.5	of mouth of river, N. by E. ¾ E. and S. by W. ¾ W., 275 yds. apart				
Point Haut Banc of Berck	50 24.	Tower, 92 ft. high, on N. pt. of River Authie;	4g	115	14	1868
One br. intermitting lt.	1 33.5	lt. visible and eclipsed every 6 secs.; obscured toward S. ¼ E., and over dangers Life boat				

Name and Character of Light.	Lat. N. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
SOMME RIVER.						
Crotoy tide light One fixed bright light	50 12.9 1 37.3	On N. side of entrance. Tide light, while 3 ft. water in entrance	●	25	4	1851
Hourdel Point tide light One fixed bright lt.	50 12.9 1 33.9	On mast, 33 ft. high, on S. side of entrance. Tide light, while 2 ft.	●	36	6	1852
CAYEUX One fixed & flash. lt.	50 11.7 1 30.7	Tower, 89 ft. high, on S. side of entrance. Fixed lt., with flash every 4 minutes	3d	92	15	1835
Cayeux tide light One fixed bright lt.	.....	On a mast, at 812 yds. S.W. of Cayeux light, from 3½ hrs. flood to 1½ hrs. ebb	●	36	6	1856
St. Valery-sur-Somme 1. One *red* fixed lt. 2. One fixed *green* lt.	50 11.5 1 37.5	1. On iron stand, in front of Harold's Tower... 2. From pillar, on mole-head	4a ..	25 25	5 5	1868 1877
Treport 1. One *red* fixed light 2. *One fix. br. tide light*	50 3.9 1 22.1	1. On iron stand, on end of East jetty..... 2. Brick tower, 27 ft. high, on W. mole. Bright tide light, while 6½ ft., in the channel	4a 4a	22 36	5 10	1861 1866
Dieppe						
West Mole One fixed bright lt.	49 56. 1 4.9	Stone tower, 32 ft. high. Flag by day.	4a	39	10	1834
East Mole *Tide Lights* Three fixed bright lts.	.....	On a mast. Lowest lt. all night; highest lt. from 2½ hrs. before to 2 hrs. after high water; middle lt. from 2 hrs. before until high water. The two latter not shown when harbour is inaccessible	●	23 31 27	4	1843
AILLY POINT One rev. br. lt., 1 min.	49 55.1 0 57.5	Square tower, 66 feet high, on the point. Eclipses not total within 12 miles	1b	305	27	1852
St. Valery-en-Caux 1. One *red* fixed light 2. *One bright tide light*	49 52.1 0 42.7	1. Red lt. on end of E. jetty. Flag by day ... 2. Tide lt. on brick tower, 31 ft. high, near end of W. jetty, while 8½ ft. water	4a ●	24 33	5 6	1857 1857
FECAMP One fixed bright light	49 46.1 0 22.1	Square tower, 56 ft. high, on Fagnet Point, above the chalk cliff. Sometimes obscured by fog	1a	426	25	1836
Fecamp Harbour *Fixed lt., with flash*, 3 m.	.....	On N. jetty, while 10 ft. Fixed red lt. on S. jetty	4c 4a	39 27	10 6	1838 1859
RIVER SEINE.						
LA HEVE Two fixed bright lts.	49 30.7 0 4.1	Two towers, 66 ft. high, on the summit of the cape, S.W. ½ S., 69 yds. apart. MAGNETO-ELECTRIC lights	1a	397	25	1845
HAVRE 1. One fixed br. lt. 2. Two fixed *red* lts.	49 29. 0 6.1	1. On N.W. jetty. 2. One on S. pier in line with another on great quay lead into harbour..... A lantern, with coloured glasses, on the quay. Lifeboat station.	4a	36	10	1843
Hoc One fixed bright lt.	49 28.8 0 11.2	On the point, N. bank of River Seine	4a	39	10	1841
Mesnil	.....	One fixed lt., 1½ mile from Tancarville	4a	23	7	1861

Name and Character of Light.	Lat. N. Long. E. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
RIVER SEINE—(*continued*).						
Quillebœuf One fixed bright lt.	49 28.5 0 31.5	S. shore of River Seine. On N. end of quay... Between Quillebœuf and Caudebec several fix. lts. are shown on either bank of the river. Between Caudebec and Rouen, 15 br. lts. on the right bank, and 12 red lts. on the left bank of the river, are shown	5a	33	10	1862
La Roque	.....	Bright fixed light on South point.....	4a	180	18	1867
La Roque Bank	.....	One red light on extreme of spit	..	..	..	1863
Rille River	.....	One red fixed light to South	4a	33	7	1867
Seine Canal	.....	One bright fixed light on North embankment	..	..	5	1850
Berville	.....	One bright fixed light ½ mile West of church	1d	420	20	1850
FATOUVILLE One fixed & flash. lt.	49 24.9 0 19.4	Octagonal tower, 105 ft. high, on the heights. Bright lt., with red flash, every 3 minutes...	1d	420	20	1850
Honfleur 1. One fixed br. lt. 2. One fixed *red* light 3. Tidal lights 4. One fixed *green* lt.	49 25 5 0 13.6	1. On hospital jetty, N.W. end of town. 2. White iron tower, 39 ft. high, on W. pier... 3. From brick tower on end of E. pier. Shown while 6½ ft. or more water in channel. Additional depth shown by flashes; each red flash indicates 3 ft. 3¼ in. (1 metre) additional, and each green flash 10 in. (¼ metre) ..... 4. At extreme of breakwater constructing	3a	82 33 39	14 6 9	1857 1876 1876
TROUVILLE						
1. Deauville One *red* fixed light	49 21.8 0 4.7	1. On W. side of entrance to Touques River. Visible between N. by E. and W. by N. ½ N.	4a	62	10	1853 18[illegible]5
2. East Pier One *green* fixed lt.		2. Near end of East Pier.....	4a	33	7	1860
3. West Pier *One tide light*		3. Near end of W. Pier; lighted when 6½ ft. in in channel. Br. seaward, red to E. of N.E. by N. up Villerville Chan., and inside entr.	5a	26	8	1875
	Long. W.					
Dives *Two red tide lights*	49 17.7 0 5.3	On Beuzeval Mount and Fort, while 6 ft. water. In one, lead in.....	.. ..	148 10	9 7	1866
L'Orne River Two fixed bright lights *One red tide light* One *green* light	49 16.6 0 15.6	Bright lts. on church and redoubt of Oyestreham, W. side of entrance. In one, S.W. ¼ S., 1,203 yds. apart. Red tide lt. on W. jetty, from 3 hrs. before to 3 hrs. after high water On E. side of channel, at Oyestreham; shown from 3 hrs. before to 3 hrs. after high water	5a ● ● ●	92 39 .. 30	10 5 4 4	1843 .... 1855 1878
Courseulles One fixed bright light	49 20.3 0 27.5	On a mast, on W. jetty head	●	30	6	1857
POINTE DE VER One fixed & flash. lt.	49 20.5 0 31.2	Square tower, 43 ft. high, on a hillock, 800 yards from the shore. Fixed lt., with flash every 4 minutes	3d	138	15	....
Port-en-Bessin Two fixed lights	49 21.1 0 45.6	In one, S.W. by W., 79 yds. apart. High tide lt. is red, while 12 ft. on the bar	● ..	131 92	8 6	1854
Grandcamp One fixed bright light	49 23.4 1 2.6	On a mast, 875 yds. West of church	●	26	3	1856
Port D'Isigny Two fixed bright lights	49 19.3 1 6.7	In one, S. by W. ½ W., 306 yds. apart, lead in	● ..	46 23	10 8	1852
Carentan One *red*, one bright lt.	49 20.6 1 11.3	Bright lt. at Brevand; red lt. on sea bank. In one, S.W. ½ W., lead in	● ..	49 16	7 7	1868

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
St. Marcouf One fixed bright light	49 29.9 1 8.9	On the fort, East of Sand-fly Island	4a	56	10	1840
Morsaline One fixed bright light	49 34.3 1 19.4	On the mound; much higher than La Hougue light. In one with it, shows N. limit of roads	5a	282	10	1836
St. Vaast La Hougue One *red* fixed light	49 34.2 1 15.6	A small tower, 29 ft. high, on jetty.	..	36	5	1865
La Hougue One fixed bright light	49 34.3 1 16.4	Square turret, 29 ft. high, at S. end of fort ...	4a	36	10	1836
Saire Point One fixed bright light	49 36.4 1 13.9	On Reville Redoubt. In one with Cape Barfleur lt., shows E. limit of dangers off Tatihou Island.....	4a	36	10	1836
Barfleur Two fixed bright lights	49 40.1 1 15.8	On South side of entrance, S.W. by W. ½ W., 309 yds. apart. In one, lead in. Lifeboat ...	6a 6a	23 43	8 9	1844 ....
CAPE BARFLEUR One br. rev. lt., ½ min.	49 41.8 1 16.	Circular tower, 233 ft. high, on the cape. Eclipses not total within 12 miles	1b	236	22	1836
Levi Cape One fixed and flash. lt.	49 41.8 1 28.5	Tower, 103 ft. high. Light bright, with red flash every 3 minutes	4d	115	12	1858
Béquet Port One bright, one *red* lt.	49 39.2 1 32.9	In one, S.W. ½ S., 76 yds. apart, lead into the harbour	● ..	28 24	9 7	1862
CHERBOURG. Port de Commerce	.....	Red lt. on E. jetty, green lt. on head of W. jetty	4a	33 15	3 2	1838 1876
Pelee Island One fixed bright lt.	49 40.3 1 35.1	On Fort Imperial	5a	85	10	....
La Digue 1. One fix. & flash. lt. 2. One fixed *green* lt. 3. One *red* light	49 40.1 1 37.2	1. A white stone tower, 54 ft. high. Lt. br. fixed, with flash every 3 min., on central fort 2. Green light on eastern head ..... 3. Red light on W. head of breakwater	5d ● ●	66 63 39	10 4 10	1839 18.3 1853
Querqueville Fort One fixed bright lt.	49 40.3 1 41.1	Turret, 52 ft. high, on the guard-house. Lifeboat station	4a	59	10	....
CAPE DE LA HAGUE One fixed bright light	49 43.4 1 57.3	Circular tower, 154 ft. high, on the top of Gros du Raz Rock, half a mile W. ½ S. from the cape	1a	157	18	1837

CHANNEL ISLANDS (British).

Alderney

Bray Harbour Two red lights	49 43.3 2 12.1	One on old pier; screened over all dangers. The other to S.W. by W. In one, they lead in	.. ..	55 25	5 3	1859
CASKETS or Casquets One flashing bright lt.	49 43.3 2 22.7	Tower on the highest rock. Light shows 3 flashes of 2 seconds, in quick succession, once in ev. ½ min.	● ..	113 ..	15 ..	1723 1877
HANOIS ROCKS One *red* rev. lt., 45 secs.	49 26. 2 42.2	A grey granite tower, 117 ft. high, on S.W. rock; obscured by Guernsey, from W. by S. to N.W.	1b	100	14	1862

Guernsey

St. Peter Port 1. One *red* fixed lt. 2. One br. fixed lt.	49 27.2 2 31.5	1. At entrance of inner harbour; bearing W. by N. ½ N., it leads in ..... 2. On E. extremity of Castle Cornet breakwater. A temporary green lt. on N. jetty...	4a 3a	40 59	6 12	1832 1867

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CHANNEL ISLANDS (British)—*continued.*						
Jersey						
Verclut Breakwater One fixed bright lt.	49 13·3 2 0.5	White iron tower, on the outer end, in St. Catherine's Bay	5a	60	10	1857
St. Helier						
1. One fixed br. lt.	49 10.5	1. Br. lt. on Victoria or new S. pier	●	31	6	1858
2. One fixed *red* lt.	2 7.3	2. Red lt. on Albert or N. pier	●	15	3	1859
3. One fixed *red* lt.		3. Red lt. on upper pier road	..	46	3	1858
4. Two *green* lights		4. On Albert pier and esplanade	..	23	3	1867
Goeray Pier Head	.....	One fixed bright light	..	55	..	1857
LA CORBIERE ROCK One br. or *red* fix. lt.	49 10.7 2 14.8	Tower 62 ft. high. Lt. is bright seaward from N. by W. to S. by E., and red eastward of these bearings, to N.E. over Rigdon Bank, and to S.E. over Les Vracheres.	2a	119	17	1874
Dielette	49 33·3	1. On end of new pier; shows br. seaward and red from N.N.W. towards land over Huquets de Jerbourg and Basses St. Gilles. In line with inner red lt. S.S.E. ¾ E., leads in	..	23	9	1876
1. One fix. *red* or br. lt.	1 52.					
2. One fixed *red* light						
3. One fixed *green* lt.		2. At head of harbour. Lifeboat	●	75	9	....
		3. On old jetty head		23	6	1856
CAPE CARTERET One rev. br. lt., ½ min.	49 22.4 1 48.5	Square tower, 49 ft. high, 100 yds. E. of cape. Life-boat station	2b	262	18	1839
Portbail One bright, one *red* lt.	49 20. 1 43.	On church tower and Point Dune. In one, S.W. ½ S., 953 yds. apart, they lead in	4a ●	64 33	8 6	1859
Senequet One fixed *red* light	49 5·5 1 39.8	Tower, 77 ft. high, on the Senequet Rock, in Deroute Passage	3a	55	10	1861
Regneville One fixed bright light	49 0.5 1 34.9	Square tower, 24 ft. high, on Agon Point	4a	33	10	1856
CHAUSEY ISLANDS One fixed and flash. lt.	48 52.2 1 49.4	Square tower, 56 ft. high, on S.E. point. A br. lt., with red flash every 4 minutes	3d	121	15	1847
MINQUIERS LT.-VES. Two bright fixed lights	48 53.6 2 17.5	Near S.W. extreme of plateau; two black balls.	4a ..	39 26	10 8	1865
GRANVILLE	48 50.1	1. Tower, 42 ft. high, on Granville Rock, or Cape Lihou	3a	154	15	1825
1. One fixed bright lt.	1 36.9		4a	40	4	1839
2. One fixed *red* light		2. Red lt. on S.E. end of mole head, W. side of entrance. Lifeboat				
Couesnon River One fixed *red* light	48 38.2 1 30.8	On W. side of Mont St. Michel, from 2 hours before to 1½ hour after high water	4a	56	6	1871
La Pierre de Herpin *Proposed light*	48 44. 1 49.3	Proposed on rock, West of St. Michel Bay	..	..	..	....
La Houle One fixed *red* light	48 40.2 1 51.2	Tower, 37 ft. high, on La Fenetre Island, at Cancalle	4a	33	6	1867
ST. MALO						
Ballue One *green* fixed light	48 37.6 2 0.3	Square tower, upper part black, on the hills, at 1,804 yds. S.S.E. ¾ E. from Sablons lt.	●	221	9	1868
Anse des Sablons One flashing *green* lt.	.....	Shown in place of fixed green lt. Kept in line with fix. green lt. at Ballue, bearing S.S.E. ¾ E., will lead to road of St. Malo	●	60	8	1877
St. Malo One bright fixed lt.	48 39. 2 1.7	Tower, 31 ft. high, on the mole des Noirs	4a	33	10	1842
Le Grand Jardin One fixed & flash. lt.	48 40.2 2 5.1	Tower, 92 ft. high, on S. end of islet. Light bright; flashes red and green alternately every 20 secs.	4d	65	12	1868
Roche Bonne One *red* fixed light	48 40.3 1 58.8	Tower, 59 ft. high, N. of St. Hyduce. Light shown from W. by N. ¼ N. to N.W. by W. ¾ W.	●	128	6	1868

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CAPE FREHEL	48 41.1	Octagonal tower, 72 ft. high, on the cape, S.W.	1b	259	22	1847
One rev. br. lt., ½ min.	2 19.2	from old tower				
Legue Port	48 32.2	Round tower, 40 ft. high, on the jetty at Point	4a	45	10	1857
One fixed bright light	2 43.2	Aigle, St. Brieuc				
Iles Saint Quay	48 40.	Tower, 33 ft. high, on Harbour Island	4a	49	10	1850
One fixed bright light	2 48.6					
Binic Port	48 36.1	Round tower, 33 ft. high, on Penthievre mole	4a	36	10	1854
One fixed bright light	2 49.					
Portrieux	48 38.8	White tower, 33 ft. high, on end of new pier	●	29	7	1853
One fixed *red* light	2 49 5					
Paimpol	48 47.5	On Portzdon Point, N. side of entr. to harbour.	..	35	7	1880
One flashing *red* or br. light	3 1.7	Red betw. S.E. by E. ½ E. and E. by S. ¾ S., bright thence to E. by S. ½ S.; obscured in all other directions. Approaching Paimpol, keep within sector of bright light				
Trieux River	48 50.2	1. On Bodic heights, on W. side of channel;	..	176	12	1867
1. Two br. flash. lts., 8 s.	3 3.2	and on La Croix Rock, on E. side; 2 miles	..	45	10	
2. Two *red* fixed lts.		apart. Shown only in channel	●	151	8	1869
		2. On end of Coat-Mer Peninsula. In one, S. 39 E., lead up from La Croix lt. to the anchorage				
Brehat Isle	48 51.9	On Paon Point and Rosedo Hill. In one, W. ¾	4a	67	6	1860
Two fixed *red* lights	2 59.3	S., ¾ mile apart. Paon Pt. lt. shows a sector	●	90	8	....
		of br. lt., vis. 12 miles, betw. S.E. by S. ¾ S. and S.E. by S. Keep within br. lt. till Portzdon bright lt. is seen. Lifeboat station				
ROCHES DOUVRES	49 6.5	A fine iron tower, painted white, 118 ft. high.	1b	180	25	1869
One flashing light	2 48.9	Eclipsed every 4 secs.				
HEAUX DE BREHAT	48 54.5	A circular tower, 157 ft. high, on N.E. side of	1a	148	..	1835
Red fixed light, and *red* flashing light	3 5.3	rocks. A red flashing lt. is shown to N.E. over Barnouic Ledge, betw. E.N.E. & E. ¼ N. A red fix. lt. is shown to S.E. over the dangers betw. S E. ¾ S. & E. by S. ¾ S. Between these two sections of red lt. is a space of 23° clear of danger, except the Roch-ar-Bel				
SEPT ILES	48 52.7	Tower, 52 ft. high, on E. end of Ile aux	3d	184	15	1835
One fixed and flash. lt.	3 29.5	Moines. Flash every 3 min. Hidden to E. ¾ N. by Rouzic Island, &c.				
TRIAGOZ	48 52.3	Tower, 92 ft. high, on Guen Bras Rock; red	3d	98	12	1862
One fixed and flash. lt.	3 38.9	and bright flashes alternately every ½ min.				
Treguier River	48 51.5	1, 2. Bright light on Harbour Mill; red lt. on	4a	105	9	1864
1. Outer fixed br. lt.	3 8.	St. Antoine Mill. In one, S.S.E., lead into	4a	46	6	
2. Inner *red* light		the Grand Passe	..	38	..	1876
3. One fixed light		3. Shown from La Corne Rock. Sector of 7½° green lt. in channel to E.N.E., red S. of that bearing. A sector of 7½° br. lt. over inner anchorage to W.S.W.				
Perros Road						
1. One fixed bright lt.	48 48.1	1. Near Nantouar Bridge	●	33	10	1860
2. One fixed bright lt.	3 23.9	2. Near Kerjean Farm, 750 yds. S.E. of No. 1. In one, they lead up the western channel	●	253	12	1860
3. One bright fixed lt.	48 46.7	3 Behind Pigeon-house, on S. shore of bay	●	89	12	1860
4. One bright fixed lt.	3 28.4	4. Near Kerprigent Mill, 3,133 yds. S.W. of Pigeon-house lt. In one, they show the direction of the eastern channel, and into the road	●	259	14	1860
Ploumanac'h Port	48 50.3	Square tower, 36 ft. high, on the point	4a	69	5	1860
One fixed *red* light	3 29.1					
Morlaix						
1. Ile Noire	48 40.4	1. Square tower, 43 ft. high. Light, with	4d	46	10	....
One fixed & flash. lt.	3 52.6	flash every 2 min. Tidal signals for Treguier Channel				
2. Tour la Lande	48 38.2	2. Square tower, 56 ft. high. Nos. 1 and 2 in	●	..	..	....
One fixed bright lt.	3 53.2	one, show the direction of the eastern channel				
3. One *red* fixed light	.....	3. On the Chateau du Taureau for the anchorage in N. part of Morlaix Road	●	34	2	....
4. One bright fixed lt.	.....	4. On Jardin or Louet Island. Nos. 4 and 2 in one, show the entrance of the western or Grand channel. Pilots necessary	4a	52	10	1860
Roscoff	48 43.5	Shown from an iron standard on the extreme	..	22	7	1880
One fixed bright light	3 58.8	end of the mole				

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
ILE DE BAS One rev. br. lt., 1 min.	48 44.7 4 1.7	Circular tower, 131 ft. high, on W. part.	1b	233	24	1836
Pte. de Pontusval One bright fixed light	48 40.7 4 21.2	Square building, 43 ft. high, on the point	a	59	10	1869
ILE VIERGE One fixed and flash. lt.	48 38.4 4 34.2	Square tower, 101 ft. high, on E. point. Bright fixed light, with red flash every 4 minutes...	3d	108	15	1845
Abervrac'h						
1. One *red* fixed light 2. One bright fixed lt.	48 36.9 4 34.7	1. White tower, 36 ft. high, on Vrac'h Island. Life-boat station ..... 2. On W. side of Plouguerneau Steeple, at 70 ft.; both lts. shown down the channel. In one, S.E. by E. ½ E., 1¾ mile apart, lead into the channel.....	4a 4a	89 170	7 12	1845 1868
3. One *green* fixed lt. 4. One bright fixed lt.	48 35.8 4 33.5	3. On E. point of Palue Beach ..... 4. At head of St. Antoine Creek. In one, lead to anchorage	● 4a	29 49	3 4	1845
OUESSANT, or USHANT						
1. One bright fixed lt. 2. One *rev.* lt., 20 secs.	48 28.5 5 3.5	1. Two towers united, 85 ft. high, on the N.E. point ..... 2. Circular tower, 152 ft. high, black and white bands, on Creac'h, or N.W. point. Light twice bright, once red.	1a 1b	272 223	24 22	 1864
LE FOUR ROCK One alternating fixed or flashing light	48 31.3 4 47.5	Stone tower, 22 ft. high. Lt. bright and fixed for 30 secs., then 8 flashes for 30 secs.....	3b	92	15	1874
Corsen Point One fixed bright light	48 24.9 4 47.8	Chenal du Four. On S. wall of Semaphore building. Shown over an arc of 8°, indicating channel betw. Grand Vinotière to W., and Petite Vinotière and Basse des Renards to E.	..	105	14	1881
Conquet Port One fixed bright light	48 21.7 4 47.5	Square tower, 59 feet high, on Kermorvan Point. Lifeboat station	3a	72	12	1849
LES PIERRES NOIRES One *red* flashing light	48 18.7 4 55.	Square tower, 82 ft. high, on Le Diamant Rock. Flash ev. 10 secs. Rocks stretch ¼ mile to S.W.	3b	90	12	1872
ST. MATHIEU One rev. br. lt., ½ min.	48 19.8 4 46.7	Tower, 82 ft. high, on the point.....	2b	177	18	1835
BREST						
Minou Point One fixed bright lt.	48 20.2 4 37.	Tower, 79 ft. high, on Petit Minou Point	3a	105	15	1848
Portzic Point One fixed & flash. lt., 3 min.	48 21.5 4 32.2	Tower, 108 ft. high, 4 miles E. ¼ S. of Minou light. In one with Minou light, N. 69° E. true, leads clear to the entrance of Brest Channel.....	2d	184	18	1848
Brest 1. One *green*, 1 *red* lt. 2. One bright, 1 *red* lt.	48 22.7 4 29.2	1. White iron towers on the jetty heads of Port Napoléon. 2. At Commercial Port. Br. lt. at end of E. pier, red lt. on W. end of S. pier	4a	33	7	1868
Brest, Bay of One bright fixed lt.	48 19.2 4 34.6	On Capucins Pt., W. side of Kelern Peninsula. Lt. shown eastward betw. E. ¼ N. & E. by S. To the northward a ray of lt. is shown over Les Fillettes Rocks	3a	207	13	1864
Toulinguet Point One fixed *red* light	48 16.8 4 37.9	Square tower. 39 feet high, on S.W. side of entrance. Lifeboat	4a	161	10	1849
Douarnenez Bay One fixed bright light	48 6.2 4 21.4	Round tower, 31 ft. high, on summit of Ile Tristan. Lifeboat station	4a	114	10	1857
Port Douarnenez One fixed *red* light	48 5.8 4 19.5	Iron pillar on Rosmeur mole.....	..	23	5	1872
ILE DE SEIN One fixed and flash. lt.	48 2.7 4 52.	Round tower, 142 ft. high, on North point of island. Bright flash every 4 min. Lifeboat station. (Proposed to be shifted to West extreme of Chaussée)	1d	148	20	1843
Ar-men Rock (Flashing bright light proposed, 1881)	48 3. 4 59.8	Lt.-ho. building on western part of Chaussée de Sein, 4½ miles West of Isle de Sein lt.-ho.	..	90	..	....

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established
RAZ DE SEIN						
TEVENNEC ISLAND One flashing lt. every 4 secs.	48 4.3 4 47.8	Lt.-ho. of brick, 52 ft. high; lt. shows white in channel to S., betw. S. ⅛ W. and S. by E.; red from S. by E. to S.E. ⅝ E.; and white to N., from S.E. ⅝ E. to W. by N. ¾ N.; obscured over the Chaussée de Sein.	..	92	13	1875
POINTE DU RAZ Two fixed bright lts.	48 2.4 4 44.1	In one with Ile de Sein lt., shows direction of Chaussée. High lt. from square tower, 49 ft. high. Lower lt., 220 yds. distant, shows only 2 sectors, one over La Vieille rocks, betw. W. and N.W. ¼ W.; the other betw. N. by W. ¾ W. and N. by E. in channel to E. of Tevennec. These two lts. in line lead on to the Plate Rock W. of Tevennec.	1a ..	259 207	18 10	1843 1875
Audierne Port 1. One fixed *red* light 2. One fixed bright lt.	48 0.6 4 32.5	1. On Raoulic Point 2. Near Capuchin Garden. In one, N.E. ½ N., 1,203 yds. apart, lead clear of Gamelle Rocks	● 5a	36 69	5 12	1856 ....
PENMARC'H POINT One rev. br. lt., ½ min.	47 47.9 4 22.6	Circular tower, 131 ft. high, on the point, near the church of St. Pierre	1b	135	22	1835
Guilfinec Two *red* fixed lights	.....	At 3¼ miles eastward of Penmarc'h. Shown only through the channel. In one, E. by N. ½ N., 620 yds. apart, lead in	.. ..	50 19	9 4	1871
Loc-Tudy One bright fixed light	47 49.9 4 9.6	Round tower, 31 ft. high, on S. side of Pont l'Abbé River entrance	4a	35	10	1863
Odet River One fixed *red* light One bright light	47 52.3 4 6.8	Round towers, 36 and 30 ft. high, on Coq Point. In one, S. ¾ W., 291 yds. apart, lead in	4a ●	33 56	7 9	1848
GLENAN ISLANDS One fix. *red*, bright and *green* light	47 46.5 4 1.8	Lt.-ho., a brick tower, 49 ft. high, on Isle aux Moutons. Lt. red betw. N. by W. ¾ W. and W. by N., green betw. W. by N. & W. by S. ⅝ S., br. over fairway betw. W. by S. ¾ S. & S.W. ¼ W., red betw. S.W. ¼ W. & S.E. ¼ E., & br. betw. S.E. ¼ E. and N. by W. ¾ W.	.. .. ..	59	12 8 7	1878 ....
PENFRET One fixed and flash. lt.	47 43.3 3 57.3	Square tower, 72 ft. high, on North point of island; one of the Glenan Islands. Fixed lt., with flash every 4 minutes	3d	118	15	1828
Concarneau Two fixed bright lights	47 52.2 3 55.2	On Croix Battery, and betw. Concarneau and Beuzec. In one, N.E. ½ E., 2,052 yds. apart, show Concarneau Road	4a ●	46 177	9 12	1849
Lanriec	.....	Red light on E. shore of Concarneau Port	●	135	9	1857
Aven River White, *red*, or *green* lt.	47 48.1 3 44.5	On the Bec-ar-Vechen. Bright lt. in fairway, from W. by S. ¾ S. to S. by E.; red to S.; green to N.	..	125	8	1868
Douelan Port Two bright fixed lights	47 46.3 3 35.7	Turrets, 33 ft. high each, on E. & W. of entr. In one, S. ¾ W., 356 yds. apart, they lead in	4a 4a	82 118	8 ..	1861 ....
ILE DE GROIX 1. One fixed bright lt. 2. One fixed & flash. lt.	47 38.9 3 30.8	1. Square tower, 75 ft. high, on Penmen Pt., at N.W. end of island, ⅛ of a mile in-shore... 2. Square tower, 39 feet high, on Fort de la Croix, on E. part of island. Red flash every 3 minutes. Lifeboat station	1a 4d	194 171	18 10	1839 1845
L'Orient 1. Two fixed bright lts. 2. Two fixed bright lts. 3. Two fix. leading lts. 4. Two fix. leading lts.	47 44.9 3 20.8	1. One on church tower, one at Laperrière. In one, N.N.E. ¾ E., lead into Little Pass 2. E. side of Grand Passe. In one, E. ½ N., lead into Grand or Western Passage 3. At Keroman Creek. High red lt.; lower green lt., S. 12° W. from high lt. In one, lead between Turc Bank and opposite shoals 4. At Kernevel Bay. High lt. red; low lt. green, N.E. ¾ E., 328 yds. from high lt. In line astern indicate channel, from their intersection with the line of Keroman lts. to Penmané anchorage	● ●

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
BELLE ILE—(*continued*).						
KERDONIS POINT One fixed br. and *red* flashing light	47 18.7 3 3.7	East extreme of island. Square stone lt.-ho., 36 ft. high, showing fixed bright light for 25 secs., followed by 5 red flashes in 25 secs. ...	c	116	12	1879
GOULFAR BAY One rev. br. lt., 1 m.	47 18.7 3 13.7	Circular tower, 151 ft. high, on S.W. part of island	1b	276	27	1836
PTE. DES POULAINS One br. flash. lt., 5 s.	47 23.3 3 15.2	Square white tower, 54 ft. high, on N. pt. In one with Goulfar Bay lt. clears Birvideaux	3d	112	14	1868
Les Grands Cardinaux One fixed bright lt.	47 19.3 2 50.2	Cylindrical stone lt.-ho., 80 ft. high, on Grongue-Gues Rock, S.E. of Hædik Island	a	89	12	1880
QUIBERON BAY						
La Teignouse One fix. & flashing lt., 3 min.	47 27.4 3 2.8	Circular tower, 51 ft. high, on the rock, S.E. of Quiberon Peninsula. In one with Navalo light, leads to W. entrance of Pass	4d	59	12	1845
Port Haliguen One fixed bright lt.	47 29.2 3 5 9	Tower, 37 ft. high, on N. jetty. Lifeboat station	4a	40	10	1856
La Crac'h One *red*, one br. lt.	47 34.1 3 0.4	On left bank of river, N. by E. and S. by W., 574 yds. apart; red lt. to S. In one, lead in	4a ●	29 69	9 10	1856 ....
Navalo Port One fixed bright lt.	47 32.9 2 54.2	Tower, 33 ft. high, on the S. point of entrance to Morbihan. In one with Teignouse light, leads to W. entrance.....	4a	72	15	1864
Penlan Point One fixed bright light	47 31. 2 30.2	Tower, 31 ft. high, on the point	4a	52	10	1844
LE FOUR One rev. br. lt., ½ min.	47 17.9 2 38.1	A round stone tower, 92 ft. high, on the rock	2b	79	18	1822
Croisic Port Two fixed bright lights	47 17.9 2 31.1	On a mast near the church, N. and S., 50 yds. apart. In one, they lead in	● ..	13 33	6 ..	1838 ....
Trehic Jetty One br. or *red* fix. lt.	47 18.5 2 31.5	Stone tower, 33 ft. high, at entrance to Port Croisic. Lt. bright to between N.N.W. and W.N.W.; the rest red	5a	39	10	1874
La Banche One fixed *red* light	47 10.6 2 27.2	Stone tower, 87 ft. high, on the Turc Rock ...	..	70	9	1865
Port Pouliguen One fixed bright light	47 16.5 2 25.8	On jetty head; only visible from S. to S.E....	..	23	5	1871
LOIRE RIVER						
Point l'Eve One fixed *red* light	47 14.5 2 16.1	Marks the channel to the town of St. Martin	6a	102	6	1856
Aiguillon Tower One fixed bright lt.	47 14.6 2 15.9	Circular tower, 67 ft. high	3a	118	12	1857
Commerce Tower One fixed & flash. lt., 2 min.	47 15.4 2 15.1	Circular tower, 108 ft. high. In one with Aiguillon light, cuts E. part of Charpentier Bank; therefore keep it open a little to East. Flash every 2 minutes.....	3d	198	14	1857
Ville-es-Martin Point *Red* revol. lt., ½ min.	47 15.4 2 13.4	Stone tower, 41 ft. high	3b	33	10	1865
St. Nazaire One fixed bright lt.	47 16.3 2 11 9	On new mole head. Tide Signals	4a	26	8	1836
Paimbœuf Port One fixed bright lt.	47 17.4 2 2.	End of mole.....	4a	26	8	1855
Pierre a l'Œil One fixed *red* light	.....	From stone tower, 4¾ cables W. of Paimbœuf lt., in line with which, bearing S. 75° E., leads in main channel of Loire River	..	15	8	18.

Lights are *proposed* at St. Nicholas Island and Mindin Tower.

Name and Character of Light.	Lat. N. Long. W. ° ′	Description. &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Pornic Port One fixed bright light	47 6.6 2 7.	Square tower, 36 ft. high, on Noveillard Point	4a	59	9	1846
PILIER ISLAND One fixed and flash. lt.	47 2.6 2 21.7	Round tower, 97 ft. high, on N.W. point. Flash every 4 min. Red sector covering La Couronnes Reef; and another over the Plateau des Bœufs	2d	105	18	1829
Noirmoutiers Island One bright or *red* light	47 0.7 2 12.9	Square tower, 52 ft. high, on Pte. des Dames; white to seaward; red lt. to westward; from E. by S. to N. by E. ½ E. Red sector over Plateau des Bœufs	a	111 ..	10 7	1867
ILE D'YEU One fixed bright light	46 43.1 2 23.	Circular tower, 108 ft. high, on mound of Petit Foule, 1,860 yds. from N. point	1a	177	18	1862
Breton Port 1. One flashing *red* or bright light 2. Two fix. bright lts.	46 43.8 2 21.	1. Octagonal red lt.-ho., 20 ft. high, on extr. of N.W. pier. Shows bright betw. S.E. by E. and N. ¾ W.; red thence to N.W. ½ N. 2. One on outer jetty, N. side of entr., and one at head of harbour, 284 yds. apart. In one, lead in. A red lt. on S. side of entrance	.. .. 4a 4a	26 .. 26 66	9 6 8 9	1880 .... 1837 1845
Pte. des Corbeaux One *red* fixed light	46 41.4 2 17.2	Stone tower, 38 ft. high, on S.E. point. Lifeboat station	4a	64	7	1862
St. Gilles-sur-Vie 1. One fixed bright lt. 2. Two *red* leading lts.	46 41.8 1 56.9	1. Tower, 27 ft. high, on extr. of Grand Mole 2. For entering the harb. Shown from square stone towers. Inner high lt. 284 yds. N.E. by E. ½ E. from low lt., near Croix de Vie Quay	4a ● ●	39 75 22	7 9 9	1852 1880 ....
Sables d'Olonne 1. One fix. bright lt. 2. One fix. bright lt. 3. Two fixed *red* lts.	46 29.7 1 47.4	1. Tower, 85 ft. high, at La Chaume, on W. side of entrance to Olonne 2. On jetty, E. side of entrance. In one with La Chaume lt., shows direction of Great Channel. Lifeboat station 3. S.E. of town. In line, E. by N. ¾ N., lead up S.W. pass. Two red lts. are also shown on Chaume quay, as leading lights between the jetties	4a 4a	105 23	12 8	1826 1855
BARGES D'OLONNE One br. lt., with *red* flash	46 29.7 1 50.7	Circular tower, 90 ft. high, on the Grand Bank; red flash every 3 min.	3c	75	15	1866
ROCHE BONNE LT.-VES. Two bright fixed lights	46 12. 2 20.8	Painted red, in 26 fms., on E. part of plateau. Three masts of equal height, and balls on two of them.	● ..	46 33	10 ..	1866 ....
PERTUIS BRETON						
Grouin du Cou Point One fixed bright lt.	46 20.7 1 28.1	Square tower, 46 feet high	4a	92	10	1859 1867
Aiguillon Point One fixed bright lt.	46 16.2 1 12.4	Wooden beacon, 38 ft. high, bearing S. by E., leads on to middle channel	4a	33	10	1859
ILE DE RE						
BALEINES One rev. br. lt., ½ m.	46 14.7 1 33.8	Octagonal tower, 164 ft. high, on N.W. point. Flashes of unequal brilliancy	1b	164	22	1854
HAUT-BANC DU NORD One fixed bright lt.	46 15.8 1 35.3	Circular tower, 96 ft. high, on the shoal, 1½ mile north-westward of Baleines Point	3a	72	15	1854
Mer du Fief One *green*, one br. lt.	46 14. 1 29.	At W. side of entr. Upper lt. green; lower lt. br., E. ⅔ S., 370 yds. from upper lt. In line, lead into Mer du Fief	.. ..	36 28	5 5	....
St. Martin Port One fixed *red* light	46 12.4 1 21.9	On angle of demi-bastion, East of entrance. Shown seaward from S. by E. to N.W. by W. true	4a	52	6	1867
Port de la Flotte One fixed bright lt.	46 11.3 1 19.4	Circular turret, 28 ft. high, on the new mole. Lifeboat station	4a	30	9	1849
Chauveau Point One fixed bright lt.	46 8. 1 16.5	Circular tower, 75 ft. high, on S.E. point of island. Red sector over all rocks on South side of island	3a	59	14	1842

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Rochelle Harbour	46 9.4	Upper br. lt. on tower, 72 ft. high, on E. quay;	5a	59	10	1852
One br., one *red* fix. lt.	1 9.3	lower lt. red, on circular turret, 44 ft high, 257 yds. to W. ¾ S. In one, they lead in ...	●	46	9	1862
Ile d'Aix	46 0.6	Tower, 45 ft. high, on fort at S. point of island	4a	66	10	....
One fixed bright light	1 10.8					
Fouras	45 59.8	Basque Road. Iron pillar on end of pier, N. harbour	..	21	7	1876
One fixed bright light	1 6.					
Charente River	45 58.	1. Red & green lts. in one, S.E., 756 yds. apart,	a	45	10	1869
1. One *red*, one *green* fixed light	1 4.4	shown only toward the Rade l'ile D'Aix ...	●	25	..	....
2. Two *red* fixed lights		2. White towers, 536 yds. apart; lts. vis. toward the Port des Barques, from S. by E. ½ E. to S.E. by S. In one, lead to anchorage	●	44	9	1869
Seudre River	45 47.8	From lantern on Pointe de Mus de Loup, entr.	..	22	8	1876
One fixed bright light	1 8.7	of river. Vis. betw. S.E. ¼ S. & N.N.W. ¼ W.				
ILE D'OLERON	46 2.8	Chassiron Tower, 141 ft. high, on N.W. point	1a	164	18	1836
One fixed bright light	1 24.7	of island. A refuge beacon on Antioch Rock, at 1¼ mile to N.E.				
La Pérotine	45 58.2	One fixed bright light at end of jetty	●	38	4	1859
Chateau Port	45 53.1	One on citadel wall; the other 262 yards to	4a	33	8	1862
Two fixed bright lts.	1 11.7	N.E. ½ N. When in one, lead in	..	77	..	....
RIVER GIRONDE						
CORDOUAN	45 35.2	A handsome structure, 207 ft. high, on rock.	1b	194	27	1727
One rev. br. lt., 1 m.	1 10.5	Lt. red between N. by E. ¾ E. to E. by S. ...				1854
COUBRE POINT	45 41.5	White tower, 100 ft. high, on N. point of river,	3a	121	15	1860
One fixed bright lt.	1 15.4	N. point of entrance				
Gironde River Lt.-Ves.	45 39.9	Inside Grand Banc, in 8 fathoms, S.E. of La	●	34	10	1870
Two bright fixed lts.	1 15.8	Mauvaise Shoal	..	23	..	....
Pte. de la Palmyre	45 40.9	On a tripod, 99 ft. high, on the dunes, 4½ miles	..	167	14	1870
One alternating *red* & *green* lt., 20 secs.	1 8.6	S.E. by E. ½ E. from Pte. de la Coubre lt....				
Terre Negre	45 38.8	Circular tower, 76 ft. high; not visible sea-	3a	121	12	1865
One *green* light	1 6.5	ward, or to S. of W.S.W. and E.S.E.				
Royan	45 37.3	One on black tower, at Chay, W. of Royan;	..	88	10	1873
Two fixed *red* lights	1 2.8	the other, painted in red and white bands,	..	177	12	1873
Bright jetty light		at St. Pierre, to the N. of Royan. In one, bearing N.E. by E. ¾ E., lead into the river. Lts. only shown in that bearing				
St. George	45 36.	One on Vallière Point; one on Suzac sand-	3a	46	14	1860
Two fixed *red* lights	1 0.6	hills, at 2,734 yards E.S.E. ¼ E., true, from former; on E. bank of river	3a	121	18	1870
St. Nicolas	45 33.7	On the Dunes, W. ¾ S. from Pte. de Grave lt.	..	71	7	1873
One fixed *green* light	1 5.	Shown only to W. ¾ S. In one with Pte. de Grave lt. leads through S. channel				
Pte. De Grave	45 34.2	Square tower, 82 ft. high, on S. point of	3a	85	14	1828
One flash. lt., 5 secs.	1 4.1	entrance				1865
Tallais Bank Lt.-Ves.	45 30.7	In 2½ fathoms, on N.W. side of bank.	●	35	9	1845
One fixed bright lt.	0 59.2					
Richard	45 26.4	Circular turret, 53 ft. high, on S.W. side of	3a	105	14	1845
One fixed *red* light	0 56.	river				
Tour de By Lightvessel	45 27.7	In 2¼ fathoms, on W. bank of river, opposite	●	33	10	1860
One fixed bright lt.	0 45.3	the tower				
Mapon Lightvessel	45 17.6	In 3¼ fathoms, on W. bank of river	●	33	10	1860
One fixed bright lt.	0 45.9					
Calonge Canal	45 17.2	From iron support near entrance of canal, right	..	22	4	1879
One fixed *red* light	0 42.1	bank of river				
Lazaret	.....	One bright fixed light	..	23	5	1866

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
RIVER GIRONDE—(*continued*).						
Gaet Fixed bright & *red* lt.	45 12.2 0 44.9	White iron beacon, 20 ft. high. The light is red to eastward	4a	20	6	1858
Ile de Patiras One bright flashing lt.	45 12.4 0 42.	Square tower, on North end of island. Light flashes every 4 seconds	●	72	18	1860
Trompeloup	.....	Fixed light, on old chapel, on W. bank	..	..	..	1860
Pauillac 1. One br. fixed lt. 2. One br. or *red* fix. lt.	45 11.9 0 44.8	1. On landing-place 2. E. of Mousset, and N. of Gaet; red toward Gaet	..	..	..	....
St. Lambert One *red* fixed light	45 11.3 0 44.2	Tower, 39 ft. high	..	52	8	....
Blaye One *red*, one br. lt.	45 7.4 0 40.1	Red lt. at entrance of harbour. Bright lt. at landing-place. Yellow lt. at end of discharging-place	..	..	..	....
HOURTINS Two fixed bright lights	45 8.3 1 9.9	Square towers, each 77 ft. high, S. ½ W., 656 ft. apart, parallel with the coast	1a ..	177 177	20 ..	1863 ....
ARCACHON BASIN One fixed bright light	44 38.7 1 15.1	Circular brick tower, 156 ft. high, on Ferret Cape, N. side of entrance. Lifeboat station	1a	167	18	1840
CONTIS One br. rev. lt., ½ min.	44 5.7 1 19.4	Round tower, 125 ft. high, on sand hills, midway between Arcachon and Adour River	1b	164	20	1863
Port Cap Breton One fixed *red* light	43 39.3 1 27.	On a wall on left bank of entrance	..	26	5	1872
Adour River One fixed bright light Two *green* leading lts.	43 31.8 1 31.4	On signal tower, 45 ft. high, on S. jetty. Lt. is bright when entrance is practicable, but red when caution is necessary. Two green leading lts. when vessels can enter	4a	38	6	1860
BIARRITZ One alternating lt., 20 s.	43 29.6 1 33.3	Brick tower, 144 ft. high, on Point St. Martin. Lt. white and red alternately. Flag when practicable. Lifeboat station	1b	240	22	1861
Socoa Port One fixed bright light	43 23.7 1 41.1	Square tower, 33 ft. high, on W. point of St. Jean de Luz Bay. A red ray of 17½° shown to turning point of the two green leading lts. Lifeboat station	4a	115	10	1845
St. Jean de Luz Two fixed *green* lights	43 23.6 1 40.3	One green lt. on stone tower, 46 ft. high, 491 yds. behind E. jetty; lt. shown 10° on each side of leading mark; a second green lt. on E. jetty. In one, lead up till Socoa red lt. appears	..	52	7	1872
Two fixed *red* lights	43 24. 1 40.	Brick towers on Pointe St. Barbe, E. side of bay. In line, S.E. by E. ½ E., 411 yds. apart, lead into the bay, until the green lts. come in line	● ●	166 95	13 13	1874 ....

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Cape Higuera One fixed bright light (Temporary)	43 23.8 1 47.9	On ruin of old lt.-ho., W. side of Bidasoa Riv. For use of fishermen. (New lt.-ho. building, to be ready in spring of 1881)	..	259	10	1855 1879
Passages Port One fixed bright light	43 20.2 1 56.5	On Cape La Plata, near W. entrance	4a	486	14	1855
SAN SEBASTIAN One fixed and flash lt. One fixed bright light	43 19.5 2 0.4	White tower, 46 ft. high, on Mount Igueldo, W. side. Flash every 2 minutes On summit of Santa Clara Island	3d 6a	431 171	15 9	1855 1864
Guetaria One fixed bright lt.	43 19.1 2 13.1	Light blue tower, on N. hill of San Antonio Islet. Visible seaward from N.W. ¾ W. to S.E. ⅔ E.	5a	295	10	1863
Sumaya One bright fixed lt. (?)	43 18.7 2 15.5	Triangular yellow tower, 60 ft. high, on Mount Atalaya. (Doubtful light)	5a	135	..	1870
Lequeitio One bright fixed light	43 23.4 2 33.5	Tower, 43 ft. high, on Point Sta. Catalina	5a	148	10	1862
MACHICHACO CAPE One fixed and flash. lt.	43 27.3 2 49.4	Circular tower, 28 ft. high, on extremity of cape. Flash every 4 minutes	1d	260	18	1852
Bilbao One fixed bright light	43 22.6 3 4.	Tower, 41 ft. high, on fort, on Point Galea, W. side of entrance. Also a lt. when vessels enter, on S.W. mole head	4a	380	16	1852
Castro Urdiales One fixed and flash. lt.	43 24.3 3 16.1	On Sta. Ana Castle. Bright lt., with red flash every 3 minutes	5d	131	7	1853
Santona 1. One fixed & flash. lt. 2. One fixed *red* light	43 28.2 3 27.2	1. Tower, 44 ft. high, on Pescador Point. Flash every 3 minutes 2. Tower on Caballo Point, E. part of mount. Shown from N. by E. to S. by W. ¾ W.	4c ..	126 85	12 10	1863 1863
Santander 1. One bright fixed lt. 2. One *red* fixed light 3. One fixed *green* lt.	43 28.2 3 45.4	1. White tower, 61 ft. high, on Mouro Island. Shown seaward from N. by E. to E. by S. 2. Red lt. on Capitania 3. Brick tower, 45 ft. high, on Point Puerto, W. of entrance. Lt. is bright over Horadada Islet	5a ◕ 5a	141 33 79	12 3 4	1860 1863 1870
CAPE MAYOR One rev. br. lt., ev. m.	43 29.5 3 47.6	Tower, 101 ft. high, on the cape, 1¾ mile from entrance of Santander. A blue flag shown when tug cannot put off	2b	298	20	1839
Suances One fixed bright light	43 26.8 4 0.9	At W. side of entrance to River San Martin de la Arena	6a	118	10	1863
San Vincente de la Barquera One fixed *red* light	43 23.5 4 25.8	White stone tower on Point de la Silla, at entrance of harbour	6a	142	9	1871
Comillas	.....	Two towers for fixed lts. building on the cliffs	..	..	..	....
TINA MAYOR One bright fixed light	43 25.2 4 33.6	White tower, 33 ft. high, on Point San Emeterio, 1½ mile W. of entrance	3a	223	15	1864
Llanes River One fixed bright light	43 26.7 4 45.5	Tower, 26 ft. high, on Point San Antonio, S. side of entrance	6a	64	9	1861
Rivadesella One fixed & flashing lt.	43 31. 5 7.1	Tower, 25 ft. high, on Mount Somos. Lt. fixed, with flash every 4 minutes	3c	370	17	1861
Villaviciosa One fixed bright light	43 35.2 5 22.9	Yellow tower, 36 ft. high, on Tazones Point, W. side of entrance		220	7	1864

Name and Character of Light.	Lat. N. Long. W.	Description. &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Gijon 1. One fixed light 2. One fixed *red* light	43 35.2 5 38.	1. Tower, 30 ft. high, near Sta. Catalina Hermitage 2. At end of new mole; also a red lt at N. mole of basin	4a 4a	167 29	10 7	1865 1866
PENAS CAPE One rev. br. lt., ½ min.	43 42.3 5 49.8	Tower, 33 ft. high, on the cape	1b	338	21	1853
Aviles One fixed bright light	43 38.1 5 56.4	Yellow tower, 49 ft. high, on Castillo Point, N. side of entrance	6a	130	10	1863
Cudillero One fixed bright light	43 36.2 6 9.1	Tower, 25 ft. high, on Revallera Point	5a	94	10	1858
CAPE BUSTO One fixed & flashing lt.	43 36.2 6 28.8	Tower, 34 ft. high, on the extremity of the cape. Lt. bright, with red flash every 2 min.	3d	307	12	1858
Luarca One fixed light	43 34.5 6 32.9	Square tower, 30 ft. high, on Point La Blanca, or Atalaya, on E. side	6a	177	7	1862
ORRIO DE TAPIA ID. One fixed & flashing lt.	43 35.7 6 58.4	Octagonal tower, 32 ft. high, on the summit of the islet. Flash every 2 minutes	3d	77	15	1859
Pancha Island One fixed bright light	43 34.7 7 4.4	On house, on W. point of entrance of Ribadeo and Figueiras	5a	79	9	1859
San Ciprian Peninsula One bright fixed light	43 13. 7 28.5	On house, on Punta de Atalaya, N. extreme of peninsula	6a	121	9	1864
Barquero Harbour One bright fixed light	43 45.6 7 40.3	Tower, 24 ft. high, on Conejera Island, on E. side of entrance	6a	273	12	1864
CAPE ESTACA One rev. br. lt., 1 min.	43 47.3 7 44.3	Granite tower, 35 ft. high, on the cape	1b	307	20	1850
Port Cedeira One fixed bright light	43 39. 8 5.4	On point of Robaleira Peninsula, S.W. of town	6a	88	9	1862
CAPE PRIOR One fixed bright light	43 33.7 8 19.1	On N. point of Cape Palma	3a	448	15	1854
Cape Priorino One fixed and flash. lt.	43 27.8 8 20.6	On Chico Priorino, entrance to Ferrol. Light bright fixed, with red flash every 2 min.	4d	92	11	1864
Ferrol One *red*, one bright lt.	43 28.7 8 15.5	Fixed red lt. near La Palma Castle. Bright light on Mercantile Wharf	5a ..	38 23	8 4	1862 1865
CORUNA One fixed and flash. lt.	43 23.3 8 24.1	On tower of Hercules; quadrangular, 159 feet high. Light fixed, with flash every 3 min.	3 l	331	16	1847
Coruna	.....	Fixed lt. on St. Antonio Castle. A fixed red lt. on embarkation mole	..	..	..	....
SISARGAS ISLANDS One fixed and flash. lt.	43 21.8 8 50.2	Tower on Isla Mayor, N. peak. Fixed bright light with red flash every 4 minutes	4d	358	11	1853
Cape Villanos One fixed bright light	43 9.8 9 12.9	At Camarinas, 2 miles northward of Camarinas Bay. Obscured by cliff from S. ½ W. to S. ½ E.	4a	243	10	1854
CAPE FINISTERRE One rev. br. lt., ½ min.	42 52.7 9 15.4	Tower, 56 ft. high, on S. point of the cape. Obscured by land N. of N. ¾ W.	1b	468	20	1853

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Cape Ce One *red* fixed light	42 54.8 9 10.1	Grey tower on cape, W. of Corcubion Bay ...	5a	82	8	1860
Monte Louro One bright fixed light	42 44.3 9 3.8	On Point Quiejal, N. entrance of Muros Bay	5a	37	10	1862
CAPE CORROBEDO One fixed bright light	42 34.6 9 4 8	Tower, 41 ft. high, on the cape.....	3a	103	12	1853
Salvora Island One fixed and flash. lt.	42 27.8 9 0.4	South point. Lt. bright, with red flash every 2 minutes	4d	82	10	1853
Rua Island One bright fixed light	42 32.8 8 55.4	Grey tower, 52 ft. high, on island.....	5a	78	11	1869
Arosa Island One fixed bright light	42 34.1 8 52.	On the N.W., or Caballo Point	4a	36	10	1851
Ons Island One fixed and flash. lt.	42 22.5 8 55.1	Tower, 35 ft. high, on the summit of the island in Pontevedra Bay. Flash every 2 min. ...	5a	421	12	1865
BAYONA or CIES IDS. One rev. br. lt., ½ min.	42 12.4 8 54.1	Tower, 35 ft. high, on Mount Faro, Middle Id. (Apparatus injured, light consequently irregular)	2b	604	20	1853
Vigo One fixed & flash. lt.	42 15.3 8 41.	On castle of La Guia, 1¼ mile N.E. of Vigo. Flash every 3 minutes	4d	102	10	1844
Guardia Port	.....	Light proposed	..	..	..	....
Boeiro Island	.....	Light proposed	..	..	..	....
CAPE SILLEIRO One fixed bright light	42 6.1 8 52.6	Granite tower, 34 ft. high, on extremity of S. point of Vigo Bay.....	4a	72	17	1862

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
PORTUGAL.						
Lima River One fixed *red* light	41 41.3 8 44.	From Fort Vianna, N. bastion, N. side of river entrance	a	48	7	1878
Espozende River One *red* fixed light	41 31.4 8 40.5	Iron column on platform of old fort	a	..	7	1866
Povoa de Varzim	41 24. 8 37.	Fishing lts., 15 miles N. of Oporto	..	..	..	1857
OPORTO One rev. br. lt., 1 min.	41 9.1 8 37.2	Square tower, white with red band, at Nossa Senhora da Luz. Tide signals	4b	170	15	1834
Aveiro *Proposed light*	40 39. 8 43.	Proposed; on the pier, S. side	..	..	..	....
CAPE MONDEGO One fixed bright light	40 12. 8 55.2	A circular tower on the S. extremity of the cape; shown westward from N. to S.	●	330	20	1837
BERLENGAS One rev. br. lt., 3 min.	39 25. 9 31.3	Square tower, 100 ft. high, on Great Berlenga Island	●	365	25	1848
CAPE CARVOEIRO One fixed bright light	39 21.1 9 24.3	Square tower, 94 ft. high, on highest part	●	182	15	1790
CAPE ROCA One rev. br. lt., 1¾ min.	38 46.1 9 30.	Round tower, 52 ft. high, ¼ mile N.E. of the cape	●	598	21	1722
RIVER TAGUS						
Guia One fixed bright lt.	38 41.7 9 24.6	Hexagonal tower, 96 ft. high, at Nossa Senhora da Guia. Visible from N. by W. ¾ W., through W. and S., to N.E. ¾ E. Signals...	3a	167	15	1771
Cascaes One *red* fixed light	38 41. 9 26.	Square tower, with blue band, on S.E. angle of Sta. Marta Fort	a	52	5	1868
San Julian One fixed bright lt.	38 40.3 9 20.5	Hexagonal tower, 120 ft. high, in the fort	4a	128	13	1775 1848
BUGIO One rev. br. lt., 1¾ m.	38 39. 9 18.6	Tower of Lorenzo, 70 ft. high. Reported to revolve every 3½ minutes (1876)	●	110	16	1775
Caxias Two fixed *red* leading lights	38 41.9 9 13.8	At 2½ miles W. of Belem Castle. In line, N.E. by E. ¾ E., lead over bar until Bugio lt. bears S., when steer in mid-channel E. by S. to a position 4 cables S. of Belem Castle	● ●	310 60	18 10	1878 ....
Belem One fixed *red* light	38 40.8 9 17.9	In fort, near Belem Castle	●	30	6	1847
CAPE ESPICHEL One fixed bright light	38 24.1 9 13.	Square tower, 100 ft. high, on the cape	1a	627	25	1790 1848
Setuval, or St. Ubes One fixed bright light	38 31.1 8 53.	Circular tower, 36 ft. high, on Fort d'Outao, at W. entrance of harbour	●	490	16	1775
CAPE SINES One fixed bright light	37 57.4 8 50.7	Three-storied lt.-ho., 75 ft. high, upper part cylindrical. Light shown from N.E. ⅝ N., through N. and W., to S.E. ⅝ E.	2a	130	19	1880
CAPE ST. VINCENT One rev. br. lt., 2 min.	37 3. 9 0.	Circular tower, 52 ft. high, on the Convent, Cape San Vicente. Rep. ev. 1½ min. Lt. obscured by high land to the eastward	●	220	20	1846
CAPE SANTA MARIA One fixed bright light	36 56.2 7 55.	Circular tower on the cape	●	109	15	1850

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
GUADIANA RIVER Two *red* fixed lights	37 11.4 7 24.3	On W. end of Cancla Id., on E. side of Ayamonte River. In one, they lead over the bar. (Medo Alto light, on W. side of the river, is no longer a leading light over the bar)	.. :	22½ 21	8 ..	1861 ....
Cristina Island Two *green* lights	37 11.1 7 20.5	On the point S. of the town. In one, they lead over the bar	.. ..	26 16	7 ..	1861
Las Piedras River One fixed & flash. lt.	37 11.8 7 1.1	White tower, 36 ft. high, at Rompido de Cartaya, at entrance of river. Fixed light, with flash every 4 minutes	3c	79	14	1861
Cartaya Bar Two bright fixed lts.	.....	On white beacons, 328 yds. apart. In one, they lead across the bar	.. ..	66 56	.. ..	....
Odiel River Two fixed bright lights	37 13.4 6 51.6	On Punta del Padre Santo, on E. shore, 1½ mile within the bar of river leading to Huelva. In line, they lead in best channel	●	27 16	8 ..	1861 ....
GUADALQUIVIR RIVER						
CHIPIONA One br. rev. lt., 1 m.	36 44. 6 26.8	Yellowish-white tower, 205 ft. high, on the Cerro del Perro. The Salmedina Shoal lies 1½ mile W. by N. of it	1b	225	23	1855
Espiritu Santo One fixed *red* light	.....	S. of the fort. La Riza Spit extends 1 mile N.N.E. of it. Not shown seaward	..	..	..	1854
Malandar Point One fixed bright lt.	36 47.6 6 21.9	Tower, 30 ft. high, on the low point, opposite San Lucar de Barrameda.....	..	36	6	1854
Bonanza	.....	Fixed bright light, near the quay.....	5a	52	7	1854
CADIZ One fixed lt., with flash.	36 31.5 6 19.4	White tower of San Sebastian, 127 ft. high, on W. end of Cadiz. Bright lt., with red flash every 2 minutes	2b	146	20	1855
CAPE TRAFALGAR One rev. lt., ½ min.	36 10.9 6 1.3	Tower, 116 ft. high, on extreme of the cape, at 1¼ mile S.W. by W. true from the tower on Altos de Meça	2a	168	19	1862
TARIFA One fixed *red* lt.	35 59.9 5 36.6	Circular tower, 112 ft. high, on S. end of peninsula. Shaded ½ a mile S. of Pearl Rock.	1a	132	20	1813 1870
Carnero Point One fixed *green* light	36 4.5 5 25.8	Round yellow tower, 163 ft. high. Lt. shows to S. and E. betw. N. ⅔ E. & S.W. by W. ½ W.	5a	135	11	1874
Algeciras One fixed bright light	36 7.3 5 26.1	White tower, 29 ft. high, on mole end of Verde Island, on fort. Shown over entrance of bay, from S.E. by E. ¼ E. to S. by W.	6a	62	9	1850 1864
GIBRALTAR						
EUROPA POINT One fixed bright lt.	36 6.5 5 21.	On Victoria Tower, 61 feet high. A sector of red light over the Pearl Rock, from S.W. by W. ⅔ W. to W. ¼ S.	1a	156	15	1840 1866
New Mole	36 7.3	Stone column, 32 ft. high, near end. Red lt. temporary	4a	28	8	1867
Ragged Staff Landing-place	.....	One green gas light	..	..	..	....

MAROCCO.

CAPE SPARTEL One fixed bright light	35 47.2 5 55.7	Stone tower, 79 ft. high, ¼ a mile E. of the cape, at S.W. of entrance to Gibraltar Straits	1a	312	20	1864
CEUTA One rev. bright light	35 53.7 5 17.5	Tower, 88 ft. high, on Mosqueros Hill, Almina Point. Flash every minute or 1½ min.....	1b	587	23	1856

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
ATLANTIC ISLANDS.						
MADEIRA						
One bright fixed light, with flashes	32 43.2 16 39.5	Tower, 41 ft. high, on Fora Island, Sao Lourenzo, or E. point. Flashes every ½ minute	2c	343	25	1870
Funchal						
One fixed *red* light	32 37.7 16 55.3	On the fort, on Ilheo or Loo Rock	5a	112	8	1866
CANARY ISLES						
TENERIFE						
Santa Cruz						
1. One fixed *red* lt.	28 28.5	1. Red light on mole-head	●	26	5	1857
2. One fixed br. lt.	16 14.9	2. Bright light near extremity of mole	6a	38	9	1863
ROQUE BERMEJO PT.	28 35.2	Grey tower, 39 feet high, on Anaga Cape, East	1c	810	35	1864
One fixed & flash. lt.	16 8.1	extr. of Tenerife; bright flash ev. 3 minutes				
GRAN CANARIA	28 11.	1. Tower, 30 ft. high, on N.E. part of Isleta	3c	817	20	1865
1. One fix. & flash. lt.	15 25.3	Peninsula. Red flash every 2 minutes				
2. One fixed *red* lt.	.....	2. Red lt. on mole, Palma Town	..	..	5	1859
Lobos Islet	28 45.4	On Martino Point, on N. side of islet	6a	95	9	1865
One fixed *red* light	13 49.1					
ALEGRANZA ISLAND	29 23.8	Grey tower, 49 ft. high, on Delgado Point, E.	4b	57	13	1865
One bright revol. lt.	13 29.6	side of island. Flashes every ½ min. Shown seaward. from N.N.W. ¼ W. to S.W. by W. ¾ W. The Greigo Bank extends 1 mile to S.W.				
LANZAROTE	28 50.9	Grey tower, 31 ft. high, on Peehiguera Point,	4a	51	12	1866
One bright fixed lt.	13 52.2	S.W. extreme of island				
Port Naos	28 57.4	On E. side of Lanzarote, 125 yds. apart. In	a	47	7	1866
One fix. *red* and one fixed bright lt.	12 32.9	one, N.W. by N. ⅜ N., lead in through narrow channel. S. or low light bright		35	6	
FUERTEVENTURA	28 3.	Grey tower, 62 ft. high, on Jandia Point,	3b	108	15	1865
One rev. br. lt., 1 m.	14 31.4	S.W. extreme of island. Shown seaward, from N.N.E. ¾ E. to S.E. by E. ⅜ E.				
PALMA	28 50.1	Tower, 112 ft. high, on Cumplida, or N.E.	2b	207	25	1866
One rev. br. lt., 1 m.	17 46.9	point of Palma Island				
AZORES						
Ponta Delgada	37 44.	St. Michael's Id. 1. Shown from tower, 26 ft.	4a	47	9	1878
1. One fixed *red* lt.	24 41.2	high, situated 200 yds. within extr. of break-	..	20	5	1874
2. Two bright fix. lts.		water in progress. (Lighthouse destroyed, Dec. 1879. Temporary fix light).....	..	..	3	....
		2. One on Custom-house; one on breakwater now constructing				
Arnel Point	37 49.3	Tower and keeper's dwelling on N.E. coast of	2c	222	18	1876
One fix. & flash. br. lt. every 2 min.	25 8.5	St. Michael Island. Flashes vis. 25 miles off through arc of 240°				
CAPE VERDE ISLANDS						
Porto Praya	.....	St. Jago. 1. A fix. br. lt. on Quail Id., S. pt.	..	85	6	....
1. One fixed br. lt.		2. A fixed red lt. on Quail Island, N. pt.	..	65	2	....
2. One fixed *red* lt.		3. At new landing place, Porto Praya.....	..	..	..	....
3. One fixed *red* lt.		(These lights are private property, and not to be depended on.)				
BERMUDA ISLANDS	32 15.1	A white iron tower, 106 ft. high, on Gibbs	●	362	24	1846
One rev. br. lt., 1 min.	64 51.6	Hill, on S. side. Seen all round, except where hidden by the hills to the eastward, from N.E. ¼ E. to N.E. ¾ E., and from N.E. by E. to N.E. by E. ¾ E.				
St. David Head	32 21.7	White octagonal lt.-ho., 55 ft. high, on Mount	2a	208	18	1879
One fixed bright lt.	64 40.6	Hill, ½ mile S.W. of St. David Head. Vis. from S.W. ½ W., through South and East, to N.W. ½ N. On the bearing N.W. by N., over North Rock, the lt. is obscured by the high land of Fort Victoria, on St. George Island				

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W	Visible in Miles.	Year established.
AFRICA (West Coast).						
Senegal One fixed bright light	16 0.8 16 31.	French.] On the Government house, Ile de St. Louis	..	..	6	1843
Almadie Point One fixed *red* light	14 45.1 17 32.1	French.] Square white tower, 39 ft. high, on western rise of point, 2 miles N.W. ¼ W. from Cape Verde light	4a	85	8	1866
CAPE VERDE One br. rev. lt., ½ min.	14 43.5 17 32.4	French.] Square white tower, 65 ft. high, on the western mound of Cape Verde	..	370	27	1866
Cape Manuel One fixed *red* light	14 38.9 17 28.5	French.] Square white tower, 39 ft. high, on W. part of Gorée Bay, 6 miles S.S.E. from Cape Verde light	4a	170	8	1866
Dakar Harbour One fixed bright light	.....	French.] From iron pillar at extr. of E. pier. Small red light for mail steamer	..	15	4	1875
Gorée Island One fixed bright light	14 39.9 17 24.5	French.] In the fort, on the summit of the island	a	..	6	1843
Gorée Bay One fixed *red* light	.....	French.] Near Rufisque, East shore of bay	..	..	3	1879
Casamanze River One fixed *red* light	.....	French.] At Carabane, left bank of river, elevated 52 ft. above quay. (Gambia)	..	..	6	1879
SIERRA LEONE One fixed light	8 30.	British.] White tower, 47 ft. high, on the cape. Is red over middle ground.	..	69	15	1849
One *green* light	13 18.5	Small lt. on Government landing-place	..	..	..	1863
MONROVIA One fixed bright light	6 19. 10 50.0	Liberian.] Red tower, 40 feet high, on Cape Mesurado. Said to be out of repair, and uncertain lt. shown from flagstaff	..	..	..	1855
CAPE PALMAS One fixed bright light	7 22.1 7 44.3	Liberian.] Tower, 50 feet high, on the cape. Bad lt., visible 2 to 3 miles, and uncertain. Great caution required	..	..	..	1847
CAPE THREE POINTS	.....	A lt.-ho. to show 3rd order fix. lt. proposed	..	..	..	....
CAPE COAST CASTLE One fixed bright light	5 6.3 1 13.9	British.] White tower, 46 ft. high, in Fort William	..	192	12	1835
ACCRA One bright fixed light	5 31.8 0 11.5	Red tower on western bastion of Fort James	3a	50	12	1871
	Long. E.					
Lagos One fixed *red* light	6 26. 3 27.	Temporary. On beach, East of lagoon. Lighthouse to be erected	a	47	7	1877
Fernando Po One bright fixed light	3 45.6 8 47.0	On Fernanda (or William) Point, N.E. extremity of Isabel Bay	..	..	5	1866
St. Thomas Island One bright fixed light	0 20.5 6 42.7	Bight of Biafra. On Fort S. Sebastian, Anna de Chaves Bay	..	35	4	1866
	Lat. S. Long. W.					
Ascension	7 55.3 14 25.5	Red lt. on end of pier in Clarence Bay	..	..	..	....
	Long. E.					
ST. PAUL DE LOANDO	8 46.	1. Lt.-ho., 32 ft. high, on Cape Lagosta. Light	5c	..	15	1880
1. One fix. and flashing bright light	13 17.	shows a flash every 2 minutes	..	57	7	1863
		2. Lt.-ves. painted red, one mast with red ball, in 19 fms., about 3½ cables N.E. of Loando				1878
2. One fixed bright lt.	8 44.9	Reef. Pass to northward	..	20	..	1879
3. Two fixed *red* lights	13 16.2	3. From beacons. Outer bcn., stone, on N. end of rocks, N. ½ W. of Isabella Point. Inner beacon marks wreck. Channel lies eastward of lts. and a buoy. Time ball at Observatory				
Benguela	.....	A fixed light is reported to be shown from fort	..	..	5	....

PART II.

LIST OF LIGHTS

ON THE

COASTS OF BRITISH AMERICA

AND THE

UNITED STATES.

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
BRITISH AMERICA.						
NEWFOUNDLAND.						
BELLE ISLE	51 53.	1. White tower, 62 ft., on S. pt. of Id. Lt. shown	1a	470	28	1858
1. One fixed bright lt.	55 22.3	from S.E. by S., southward, to West. (April	●	128	17	1880
2. One fixed bright lt.		1 to Dec. 15). Depot for shipwrecks				
		2. Square white lt.-ho., 31 ft., on S. point, 300 ft. below the old lt. Lt. vis. in all directions except where obscured by the land to North.....				
CAPE NORMAN	51 38.	White tower, 40 ft. high, on N. coast of New-	●	138	20	1871
One br. rev. lt., 2 min.	55 53.7	foundland, Strait of Belle Isle				
Greenly Island	51 22.6	Lighthouse, 78 feet high, fawn colour, on S.W.	●	100	15	1878
One alternat. *red* & br.	57 10.8	pt. of Id. Lt. br. ½ min., red ½ min., br. ½				
lt. every 3 min.		min.; then eclip. 1½ min.				
AMOUR POINT	51 27.6	White tower, 109 feet high, on S.E. side of	2a	155	18	1858
One fixed bright light	56 50.9	Forteaux Bay, Coast of Labrador. From Apr. 1 to Dec. 15.				
POINT RICH	50 41.8	White tower, 40 ft. high, on North point of	●	130	18	1871
One br. flash. lt., 15 s.	57 25.5	Ingornachoix Bay				
Toulinguet Island	49 41.5	Notre Dame Bay. Red brick tower; dwelling	●	335	27	1876
One revol. bright lt. ½ m	54 47.	white on Long Point, North of island.....				
Cann Island	49 35.	S. side of Fogo Id., entrance of Seldom-come-	8a	85	12	1874
One fixed bright light	54 10.5	by Bay. Wooden tower				
OFFER WADHAM ID.	49 35.7	Circular brick tower, on the island	a	96	12	1858
One fixed bright light	53 43.5					
Stinking Islands	49 10.4	Iron lt.-ho., red and white bands, on Stinking	4c	74	10	1880
One intermt. br. lt., 20 s.	53 21.3	or Cabot Id. Lt. is br. for about 11 secs., and eclipsed for 9 secs.....				
Greenspond Harbour	49 3.6	Granite tower on Puffin Island, near entrance.	4a	55	10	1873
One fixed *red* light	53 42.4	Obscured towards the land, from S. by W. to E. by S.				
CAPE BONAVISTA	48 41.9	Tower, 36 ft. high, striped red & white, verti-	1b	150	16	1843
One rev. br. and *red* lt.	53 5.2	tically, on the cape. Lt. br. 15 secs., eclipsed 30 secs., red 15 secs., eclipsed 30 secs.				
Catalina Harbour	48 30.2	White tower, on S. side of Green Island, Ca-	●	92	15	1857
One fixed bright light	53 2.7	talina Harbour, in Trinity Bay. Shown from E.N.E., seaward, to S.W.....				
Trinity Harbour	48 22.	White tower on Fort Point, W. side of entrance	8a	75	11	1874
One bright fixed light	53 20.8					
BACALHAO ISLAND	48 8.6	Circular brick tower, 34 ft. high, half a mile	●	380	28	1858
One rev. br. lt., 20 s.	52 47.8	from N. end of island. Hidden by land within 8 miles, when bearing N.N.E. ½ E....				
Carbonear Island	47 44.3	In Conception Bay. White buildings with red	a	195	16	1878
One fixed bright light	53 9.4	roofs				
HARBOUR GRACE	47 42.7	1. Square house, red and white stripes, on N.	●	150	20	1836
1. One revol lt, ½ m.	53 8.2	end of island, at entrance; two bright, one				1869
2. Two fix. lts., vertical		red flash. Shown from S.S.W. to N.N.E....				
		2. On beach, N. side, 11 yds. apart. Bearing W. ¼ S. clear spit	●	50	10	1858
CAPE ST. FRANCIS	47 48.5	White wooden building, S.pt. of entr. to Concep-	5a	123	12	1877
One fixed *red* light	52 47.2	tion Bay.				
ST. JOHN'S	47 33.8	1. Square stone tower, 39 ft. high, on Fort	●	110	12	1852
1. One fixed bright lt.	52 40.3	Amherst, S. entr. of harb. Shown seaward,	..	225	6	1863
2. Two fixed *red* lights		from E.N.E. to S.S.W.		50		
		2. In one, N.W. ¾ W., lead through Narrows				
CAPE SPEAR	47 31.2	Square tower, 38 ft. high, red & white bands,	●	264	22	1835
One rev. br. lt., 1 min.	52 36.9	on the cape.				
FERRYLAND HEAD	47 0.	Red brick tower. Dwelling white	..	200	16	1871
One bright fixed light	52 51.					
CAPE RACE	46 39.2	Tower, 40 ft. high, on the cape, with S.E. side	●	180	17	1856
One revol. lt., ½ min.	53 3.6	striped red and white, vertically. Shown seaward, from W.S.W. to E.N.E. A conical beacon, 50 yds. from lightho.				
CAPE PINE	46 37.1	Round iron tower, 56 ft. high, with red and	..	314	24	1851
One bright fixed light	53 31.7	white bands, on the cape. Shown from E. by N. seaward, to N.W.				
CAPE ST. MARY	46 49.5	Circular brick tower, 40 ft. high, flashes red	1b	390	26	1860
One revol. lt., 1 min.	54 11.9	and bright alternately				
Placentia Harbour	47 14.2	White wooden lt.-ho., on Verde Point, S. side	5a	98	11	1879
One fixed bright light	54 0.3	of entrance				
GREAT BURIN ISLAND	47 0.4	Circular tower, 25 ft. high, on Dodding Head,	2b	430	27	1858
One rev. br. lt., ev. min.	55 8.1	South end of the island.....				
Lamelin Harbour	46 51.	Octagonal lt.-ho., wood, painted red & white,	8a	64	..	1879
One fixed bright light	55 47.	on S.E. point of Allan Island				

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
ST. PIERRE ISLAND						
Galantry Head One rev. br. and *red* light, 10 secs.	46 46.1 56 9.1	(French.) Square white tower, 36 feet high. Light revolves, with two bright flashes followed by one red flash every 10 seconds.....	2c	210	18	1862 1879
Canon Point One bright, one *red* lt.	46 47. 56 9.6	Outer lt. br., on rocks off Canon Point. In one, N.W., they lead through S. entrance	● ●	36 64	6 3	1862 ....
St. Pierre Harbour One br. or *red* fix. lt.	.....	On Leconte Pt., N. side of S. entr. Shows br. in S. channel, and red thence to N.W. ½ W.	..	62	7	1874
BRUNET ISLAND One br. flash. lt., 10 s.	47 15.5 55 51.8	Tower, 30 ft. high, on house on Mercer Head, S.E. extreme of island in Fortune Bay. Shown seaward, from W.N.W. to N.	●	408	25	1865
Garnish One fixed *red* light	47 14. 55 24.	White and red tower, S. side of Fortune Bay	..	20	..	1875
Bande de L'Arier One bright fixed light	47 49. 55 27.3	White tower on point of the beach at Bande de L'Arier or Belloram Harbour, Fortune Bay	8a	35	8	1874
Harbour Briton One fixed bright light	47 27.5 55 47.8	White tower, 14 ft. high, on Rocky Point, W. side of entr. Red ray shown over Harbour Rock	8a	68	9	1873
HERMITAGE BAY One fix. br., one *red* lt.	47 29.2 56 12.	White wooden lt.-ho., on Pass Id., S. side of entr. Lts. vertical, high lt. br. Lts. appear as one when 4½ miles distant. Low lt. red, visible from W. by N. ¼ N., through S., to S.E. by S. ½ S.....	4a 6a	281 267	19 4	1879 ....
Burgeo Islands One fixed red light	47 36.2 57 35.2	Wooden tower, with keeper's dwelling attached, on Boar Id., E. end of Burgeo Isles	6a	160	17	1874
Rose Blanche Point One fixed bright light	47 35.8 58 41.5	Granite tower on eastern head of the point ...	4a	95	13	1874
Port Basque One fixed *red* light	47 33.8 59 7.2	On Channel Head	..	..	..	1875
CAPE RAY One br. flash. lt., 10 sec.	47 37. 59 18.	White wooden building, 41 ft. high. Eclipses faint at long distances.	●	..	20	1871
GULF OF ST. LAWRENCE.						
ST. PAUL ISLAND						
North-East Point One fixed bright lt.	47 13.8 60 8.3	White tower, 40 ft. high, on a rock; obscured from S. by W. ¼ W. to W.S.W. Apr. 1 to Dec. 20	3a	144	20	1839
South-West Point One br. rev. lt., 1 m.	47 11.3 60 9.6	White tower, 40 feet high. Shown seaward, from N.N.W. to E., all the year round.	3b	140	20	1831
MAGDALEN ISLANDS						
GREAT BIRD ROCK One bright fixed lt.	47 50.7 61 8.3	White tower, 50 ft. high, on N.E. islet. April 1 to Dec. 31.	2a	140	21	....
GRINDSTONE ID. One br. rev. lt. 1½ m.	47 23 3 61 57.2	Tower near Etang du Nord, on W. side of Id., Magdalen Ids.	●	200	20	1874
AMHERST ISLAND One alternating lt.	47 13. 61 58.	White wooden building on South cape; bright and red lts., each for 30 secs.....	●	..	20	1871
Entry Island One fixed *red* light	47 16.5 61 41.	White tower, 28 ft. high, on S.E. side of Id.	●	90	10	1874
ANTICOSTI ISLAND						
HEATH POINT One fixed bright lt.	49 5.3 61 41.8	Grey conical tower, 90 feet high, on point at S.E. end of island; must be kept open southward of Cormorant Point. Provision depot for shipwrecked people	●	110	15	1831
SOUTH POINT One br. flash. lt., 20 s.	49 4. 62 15.	White tower, 50 ft. high, on Bagot's Bluff, ¾ mile from S. pt. Provision depot for shipwrecked people	●	75	14	1871
S.W. POINT One rev. br. lt., 1 m.	49 23.7 63 35.8	Conical gray tower, 75 ft. high. Shown from S.S.E., seaward, to N.W. by W.....	●	100	15	1831
WEST POINT One fixed bright lt.	49 52.5 64 32.	Round white tower, 109 ft. high, on extreme W. point. Provision depot at Ellis Bay, 8 miles to the S.E.....	2a	112	15	1858
CAPE ROZIER One fixed bright light	48 51.6 64 12.	White tower, 112 ft. high, on the cape.....	1a	136	16	1858
FAME POINT One fix. br. lt., *red* flash	49 6.8 64 36.3	Square white wooden lt.-ho., 50 ft. high. Red flash every 20 secs., visible about 12 miles...	..	200	20	1880
CAPE MAGDALEN One rev. *red* and br. lt.	49 15.7 65 19.5	White wooden tower, 54 ft. high; bright and red flashes alternately every 2 minutes	●	147	17 10	1871
MARTIN RIVER One fixed bright light	49 13.3 66 9.	White wooden tower, 54 ft. high	●	125	17	1876
CAPE CHATTE One rev. br. lt., ½ min.	49 5.9 66 45.5	Square white tower, 26 ft. high, on N.W. part of the cape	●	120	18	1871 1875

Name and Character of Light.	Lat. N. Long. W. o '	Description. &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W	Visible in Miles.	Year established.
CAROUSAL ISLAND One bright fixed light	50 5.7 66 22.7	White tower on one of the Seven Islands.....	●	200	20	1871
EGG ISLAND One br. rev. lt., 1½ min.	49 38. 67 10.	Tower, 30 ft. high, 1 cable from S. end of the island.....	●	70	15	1871
POINT DE MONTS One fixed bright light	49 19.6 67 21.9	Round white tower, 75 ft. high, 1¼ mile N.E. of point. Provision depot for shipwrecks	..	100	15	1830
RIVER ST. LAWRENCE.						
Matane One fixed br. light	48 52. 67 33.	Square white wooden building, 28 ft. high ...	●	65	10	1873
Metis Point Br. & *red* rev. lt. 1 min.	48 41. 68 2.3	White tower, 40 feet high, on Metis Point	●	56	13	1874
MANICOUGAN STRAIT LIGHTVESSEL Two fixed bright lights	49 2.7 68 14.3	In 25 fathoms, at 1⅜ mile off southern edge of shoal. Lts. at unequal heights.	a	27 24	8	1872
Father Point One fixed bright light	48 31.4 68 27.3	Rimousky. White tower on the point.	..	43	10	1859
Port Neuf	48 38. 69 6.	Bright fixed light from square wooden building on pier	●	40	11	1873
BICQUETTE ISLAND One rev. br. lt , 2 min.	48 25.3 68 53.3	Grey stone tower, 65 ft. high, on W. point.	..	112	15	1844
RED ISLET BANK Lt.-V. Two bright fixed lights	48 6.5 69 31.	Painted red; lies in 10 fathoms N.E. from Red Islet.	●	40	11	1871
RED ISLET One fixed *red* light	48 4 3 69 32.9	Round stone tower, 51 ft. high, on centre of islet, on S.W. point of the bank	..	75	12	1848
GREEN ISLAND One fixed bright light	48 3.3 69 25 1	White tower, 40 ft. high, on N. point.	..	60	13	1809
BRANDY POTS One bright fixed light	47 52.5 69 0.6	Brick tower, 39 ft. high, at S.E. end of islet, off S.E. side of Hare Island. Pass to S. ...	4a	78	10	1862
Saguenay River One fixed bright light	48 8. 69 39.	On the centre of Lark Islet.....	..	35	10	1872
LONG PILGRIMS One bright fixed light	47 43.2 69 43.	Brick tower, 39 ft. high, near centre of island	4a	180	12	1862
KAMOURASKA One bright revol. light	47 38. 69 52.	Wooden tower, 39 ft. high, near N.E. end of Grande Ile. Light revolves every minute...	●	166	12	1862
Origneaux Point One fixed bright light	47 29.7 70 1.8	Square white wooden tower, 20 ft. high, on end of St. Denis Pier.....	●	34	10	1875
GOOSE CAPE One fixed bright light	47 29.5 70 13 8	White tower, 42 ft. high	●	48	12	1876
St Paul Bay One fixed bright light	47 24 8 70 29.	White tower, 30 ft. high, on pier. N. shore of River St. Lawrence	●	36	10	1876
ST. ROQUE SHOALS						
Lower Lightvessel Two bright fixed lts.	47 22.2 70 14.9	Red; two masts and balls. In 3½ fathoms, on the N.E. part of the St. Roque Shoals, in the South Traverse.	..	..	9	1836
Upper Lightvessel Two bright fixed lts.	47 20. 70 16.	Two masts; lts. at unequal heights. In 3¼ fms., on the N.W. edge of the shoal.	..	16 24	6	1871
STONE PILLAR One br. rev. lt., 1½ min.	47 12.4 70 21.6	White stone tower, 38 ft. high, 100 yds. from S. point of islet	..	68	12	1843
Algernon Rock One fixed bright lt.	47 12.4 70 21.4	Square white lt.-ho., 32 ft., on framework on Algernon or South Rock, near Stone Pillar...	6a	36	6	1880
Crane Island One bright fixed light	47 3. 70 33.	Wood tower, 37 feet high, 1½ mile from West point of the island.....	●	44	10	1862
Cape Rouge	47 7.7	1. At Cape Rouge, to lead betw. Traverse Spit	●	230	10	1875
1. Two bright fix. lts.	70 40.5	and Brulé Bank	●	170	..	1875
2. One fixed bright lt.		2. Square white tower on Monté du Lac	●	175	10	1870
St. Francis, I. of Orleans	47 0.2	At E. end of island, to lead betw. W. Sands &	●	110	10	1875
Two fixed bright lts.	70 45.3	Traverse Spit	●	30	..	1875
St. John, I. of Orleans One br. rev. lt., ½ min.	46 55.2 70 53 5	White tower on wharf, at St. John	●	27	8	1874

Note.—The Lights in the Gulf and River St. Lawrence are shown only during the navigable season, generally from April 1st to December 20th.

The Lights on the upper part of the River St. Lawrence, and those on the great American Lakes, are omitted, as not being of service to oversea vessels.

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
St. Lawrence Point	46 51.8	White tower	●	38	8	1869
One fixed bright light	71 2.					
Belle Chasse	46 56.	Wood tower, 30 ft. high, on E. end of island	●	76	10	1862
One fixed bright light	71 2.					
Quebec Harbour	.....	A wooden tower on Agate Island; guide to the harbour	..	32	10	1872
One fixed bright light						
NEW BRUNSWICK.						
CAPE GASPE	48 45.2	Square white wooden building, 30 ft. high	●	350	12	1873
One fixed *red* light	64 9.2					
GASPE BAY						
Sandy Beach Pt. Lt.-V.	48 50.7	Painted red; off the end of Sandy Beach Point, S. side of entrance channel	..	34	..	1871
One br., 1 *red* fix. lt.	64 24.5		..	30	..	1872
O'Hara Point	.....	Red lt., only when mail steamers are expected	..	30	7	....
Perce' Bay	48 30.5	Square white wooden tower, 20 feet high, on White Head	●	138	13	1874
One fixed bright light	64 13.					
CAPE DESPAIR	48 25.7	White tower, on the Cape, Chaleur Bay	●	90	15	1874
One br. rev. lt., ½ min.	64 18.3					
CHALEUR BAY						
MACQUEREAU POINT	48 12.5	White tower, on the South point of entrance, Chaleur Bay. Lt. red and bright alternately	●	56	12	1874
Rev. *red* & br. lt., 2 m.	64 46.2					
Paspebiac Point	48 0.8	White tower, 54 ft. high, near extremity of point, on N. side of bay	●	55	13	1870
One bright fixed lt.	65 14.3					
Elm Tree Point	47 48.7	Square white wooden lt.-ho., W. side Nipisighit Bay. Visible betw. S.S.W. and N. by W.	●	36	12	1879
One fixed bright lt.	65 43.2					
Bathurst Harbour	47 39.3	On Carron Point, 356 ft. apart; outer bright lt. and inner red lt. kept in line, lead in	●	..	9	1871
One br., 1 *red* fix. lt.	65 36.6			43	9	
Caraquette Island	47 49.7	Tower, 48 ft. high, on W. end of island, S. side of bay	●	52	13	1870
One bright fixed lt.	64 53.					
Carleton Point	48 15.2	White tower, 28 ft. high. One fixed bright lt.	●	32	11	1872
Heron Island	48 0.	White wooden tower, 20 ft. high, on E. side of Heron Island, Chaleur Bay	●	66	12	1875
One fixed bright lt.	66 8.					
RISTIGOUCHE RIVER						
Dalhousie Harbour	48 4.7	1. Square white tower, 33 ft. high, on Bonami Point, South side of entrance	●	49	13	1871
1. One fix. br. lt.	66 22.5		●	24	..	1879
2. Two fix. br. lts.		2. Outer lt. from public wharf; inner lt. from Montgomery Island	●	27	..	
Oak Point	48 2.7	Two square white wooden lighthouses, 22 ft. high, N. bank of river; one lt. shown E. &	●	40	..	1879
Two fixed br. lts.	66 36.5	the other W. A br. fix. lt. shown from inner lt.-ho. in one with the outer lt. guides vessels crossing the Traverse	●	45	..	....
Campbelltown	48 0.8	On South bank of river, from wharves	●	24	..	1879
Two fix. bright lts.	66 39.7					
MISCOU ISLAND	48 1.	1. White tower, 74 ft. high, on Birch Point, N. pt. of Id.	●	79	12	1856
1. One fixed *red* light	64 29.4		●	40	10	1875
2. Rev. br. lt., 1 min.		2. Tower, 28 ft. high, at Goose Lake, W. side of island				
Shippigan	47 43.	1. White wooden building, 20 ft. high, on Alexander Point, E. entrance point of Gully	..	32	10	1873
1. One fixed bright lt.	64 39.5		..	22	9	1880
2. One fixed bright lt.		2. Shown from a lantern on a pole, 454 ft. S.W. by W. from the main lt. These lts. kept in line lead up to a buoy placed outside the bar				
Pocmouche Gully	47 40.	Square white wooden tower, 37 ft. high	●	35	8	1876
One fixed *green* light	64 46.					
Tracadie North Gully	47 33.3	On N. side of Gully. In line, lead in	●	39	12	1872
Two bright fixed lights	64 51.4		●	17	..	1875

Note.—The lighthouses of Nova Scotia and New Brunswick, where necessary, are painted with black or red stripes, &c., to distinguish the towers from the land; as, after the snow is gone off the land, the accumulations against the fences, which generally run at right angles to the coast, and which continue for some time after it has disappeared from the fields themselves, have exactly the appearance of a white tower, and frequently mislead even those acquainted with the coasts.

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Tracadie South Gully	47 30.2	Upper lt.-ho. red, lower white. On N. side of	●	26	8	1877
Bright and *red* fixed lts.	64 52.	Tracadie S. Gully. N. and S., 170 yds. apart.	●	19	..	....
		In line, mark channel into harbour				
MIRAMICHI BAY						
Tabisintac Gully	.....	Red and bright lts. on Crab Island in line lead into Gully	●	30	7	1873
Negowac Gully	.....	Two br. fix. lts. in line show entrance	●	35	10	1873
ESCUMENAC POINT	47 4.5	White tower, 58 ft. high, on point at S.E. side	3a	70	14	1841
One fixed bright lt.	64 47.6	of bay				
Preston's Beach	47 4.8	White towers, 30 and 28 feet high, at Ship	●	66	10	1870
Two bright fixed lts.	64 55.	Channel entrance		55	10	
FOX ISLAND	47 8.8	1. On N.W. point of island; in one, show di-	●	50	10	....
1. Two fix. br. lts.	65 2.	rection of Horse-shoe Channel	●	32	10	1872
2. Two fix. br. lts.		2. Leading lts. for Swashway Channel, E. and W., ½ mile apart, on E. end of island				
Portage Island	47 9.8	White tower, 42 ft. high, on S. end of island	●	46	12	1870
One bright fixed lt.	65 2.7					
Inner Horse-shoe Bar	47 8.	Schooner rigged; lies between Fox and Port-	●	35	8	1873
Lightvessel	65 3.	age Islands				
One fixed *red* light						
Oak Point	47 8.	White towers, 36 feet high. In one, lead	●	60	10	1870
Two bright fixed lts.	65 15.	through the Narrows		40		
Bartiboque	47 5.	At Lower Newcastle. Bear N.E. and S.W.	●	140	10	1870
Two bright fixed lts.	65 23.	from each other		120	10	
Middle Island	47 3.5	Bright fixed light on N. side of island	●	45	7	1874
Sheldrake Island	.....	On white beacons, 500 yds. apart, on S. side of	●	48	9	1873
Two bright fixed lts.		island				
Huckleberry	.....	N.W. beacon, a conspicuous white structure;	..	..	..	1871
Two bright fixed lts.		S.E. beacon, on the E. side of a white barn.				
		In line, lead across the outer bar				
Malcolm River	.....	Fix. lts. on each of the beacons W. of Malcolm P.	..	..	..	1871
RICHIBUCTO RIVER	46 42.7	1. White square frame lt.-ho., 43 ft. high, near	●	44	12	1879
1. One fixed *red* light	64 46.2	beacons on South beach	●	40	12	....
2. One fixed bright lt.		2. Square white wooden lt.-ho., 33 ft. high, 102 yds. E. by N. ½ N. from high lt. These lts. kept in line W. by S. ½ S. lead through channel over the bar, and replace day beacons				
RICHIBUCTO HEAD	46 39.7	Fixed br. lt. from white tower, 50 ft. high	4a	70	14	1864
Shediac Bay	46 19.2	Bright rev. lt., ½ min., on Cassies Point	●	40	14	1872
Shediac Harbour	46 14.7	Approaching, keep two leading lts. on Shediac	●	50	10	1869
	64 31.8	Id. in line. Small br. lt. on Duchene Wharf				
Jourimain Island	46 10.	White tower, 40 ft. high, on island in Northum-	●	72	14	1870
One br. flash. lt., 10 s.	63 50.	berland Strait				
Pugwash Harbour	45 52.5	Square white tower, 44 ft. high, on Seaman's	●	48	8	1871
One fixed br. or *red* lt.	63 40.5	or Fishery Point, E. side of entrance; red seaward, bright toward the harbour				
Wallace Harbour	45 49.8	White building, 25 ft. high, on Mullin Point,	●	39	11	1873
Bright and *red* fixed lts.	63 24.3	N. side of entrance. Leading lts. over bar	●	..	..	
Amet Island	45 50.2	White square tower on island in Tatmagouche	●	44	12	1857
One bright fixed light	63 10.	Bay entrance				
Caribou Island	45 44.	On N.E. end of island in Northumberland	●	35	10	1868
One rev. br. lt., 1 min.	62 46.	Strait				
Pictou Harbour	45 41.4	1. Tower, 55 ft. high, striped red and white,	●	65	11	1834
1. One br., one *red* lt.	62 39.5	vertically, on S. point of entrance. Lights	..	40	..	....
2. One fixed bright lt.		vertical. Lower lt. red				
		2. From Custom-house tower, 2 miles W. ¼ N. from lt.-ho. on S. entr. pt. of river, & in line with it leads through channel seaward of bar	●	60	8	1878
PICTOU ISLAND	45 49.2	White tower, on E. point	●	52	12	1853
One fixed bright light	62 30.5					
CAPE GEORGE	45 52.6	Square white tower, 39 ft. high, on N.E. extr.	2b	350	25	1861
One rev. br. lt., ½ min.	61 54.7	of Nova Scotia. Obscured W. of N.W.				

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Pomquet Island One fixed *red* light	45 39.7 61 44.5	On N.E. point of island, near Antigonish, in St George's Bay. Obscured to West	●	50	10	1868
PRINCE EDWARD ISLAND.						
WEST POINT One rev. lt., 1½ min.	46 37.5 64 23.2	Red and white banded tower, 67 ft. high; lt. shows 3 white and 1 red flash, each flash attaining its greatest brilliancy ev. 22½ secs....	●	66	13	1876
Bedeque Harbour	.....	A bright light on Railway Wharf	●	33	10	1856
Sea Cow Head One fixed bright light	46 19. 63 48.5	Tower, on Salutation or Sea Cow Head, S.E. side of entrance to Bedeque Bay	●	88	14	1865
Crapaud	.....	A br. lt. at W. end of bridge, head of harbour	●	41	3	1879
Charlottetown One br., one *red* fix. lt.	46 11.6 63 7.5	On W. side of entr., vertical, 21 ft. apart; upper br., lower red lt. Lower lt. only visible in direction of bell-buoy	● ●	56 35	12 3	1851 1876
HILLSBORO' BAY One fixed bright light	46 3.2 63 2.1	White brick tower, 50 ft. high, on Prim Point, S.E. of bay	●	68	13	1845
SOUTH POINT	62 44.5	Br. lt. from tower, 40 ft. high, on Wood Id....	4a	80	15	1876
Little Sands	62 39.	Red lt., from window of house, 20 ft. high.....	●	50	5	1877
Murray Harbour	.....	Two fix. lts., 1 mile apart, W. by S. & E. by N.	●	57	8	1879
CARDIGAN BAY One fixed bright light	46 8.8 62 27.7	White tower, 49 ft. high, on Panmure Head, S. entrance of Georgetown Harbour. Kept open of Terrace Pt., clears reef off Bear Cape	●	89	14	1853
Georgetown One br. or *red* fixed lt.	46 9.9 62 31.4	Square white tower, on St. Andrew Point, S.W. side of entrance. Red seaward	●	36	8	1868
EAST POINT One br. rev. lt. ev. 3 m.	46 27.1 61 58.2	Octagonal white tower, 60 ft. high, on S. side of E. point.....	●	130	18	1867
St. Peter's Harbour	.....	Two fixed lights	●	..	6	1868
Tracadie Harbour	.....	Two fixed red lights in line S.W. by S.	●	40	..	1876
Little Rustico	.....	Two bright leading lts. on W. side of entrance	●	..	..	1875
Grand Rustico Two fixed lights	.....	Upper lt. br., lower red, vertical, 5 yds. apart; seen only in channel	●	..	..	1876
Grenville Harbour	.....	Upper red, lower br. lt.; seen only in channel	●	..	..	1876
Richmond Bay Two fixed bright lights	46 34.7 63 42.5	On Bill Hook, or Fishery Id., N. side of entr., E. by S. and W. by N., 400 yards apart	● ..	50 18	12 6	1856 1876
Conway Inlet	.....	Two fixed bright leading lights.....	●	26	10	1877
Cascumpeque Two fixed lights	46 48.4 64 2.3	White towers on S.W. pt. of Sandy Id., N. side of entr. Main lt. br., range lt. red, E. by S. and W. by N., 217 yds. apart	● ..	45 18	12 6	1856 1876
Tignish River Two fixed bright lights	46 57.5 63 59.3	High lt. from mast on S. side of harbour entr., low lt. on end of breakwater, 1,035 ft. East of high lt. In line, lead up to harbour	● ●	26 17	6 6	1877
NORTH POINT One br. rev. lt. ev. min.	47 3.8 63 59.3	On the low N. extreme of island. A reef extends nearly 2 miles to northward.....	●	80	12	1866 1875
CANSO GUT						
Havre Bouche One fixed *red* lt., and one fixed bright lt.	45 41. 61 31.2	Square white wooden lt.-houses on S.W. shore of harbour. Upper lt. shows red. Low lt.-ho. 473 yds. N.E. ¾ N. from high lt.-ho. These lts. kept in line indicate dredged channel ...	● ●	107 37	9 9	1879
North Entrance One fixed bright lt.	45 41.7 61 28.9	White tower, 35 ft. high, on W. side, 120 yds. in-shore	●	110	18	1842
Ship Harbour One *red* fixed light	45 36.7 61 22.	White tower, 24 ft. high, on Stapleton Point, S. side of the harbour	●	44	7	1870
South Entrance Two fixed bright lts.	45 31.5 61 14.6	Tower white, with black diamond, on Eddy Point. Lights horizontal, 8 yds. apart	●	25	8	1851
CAPE BRETON ISLAND.						
Port Hood One fixed br. or *red* lt.	46 0. 61 31.6	White tower, S. entrance. Light red to N., and bright to S.	●	54	10	1854
Sea Wolf or Margaree Id. One fixed bright light	46 21.5 61 15.5	White tower on summit, or middle of Id. On near approach, light is obscured by cliffs ...	●	298	21	1854
CHETICAN ISLAND One br. rev. lt., ¾ min.	46 36.5 61 3.	White building, 24 ft. high, with black ball, on S.W. end of island	●	149	20	1872

Name and Character of Light.	Lat. N. Long. W. ° '	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
MONEY POINT One rev. *red* or br. lt.	47 2.2 60 23.5	White wooden tower, 36 ft. high. Lt. shows alternately red and bright every 45 secs. ...	●	74	14	1875
INGANISH ISLAND One bright fixed light	46 41.3 60 20.	White wooden tower, 40 ft. high, on island ...	5a	237	15	1871
St. Anne's Harbour One bright fixed light	46 17.5 60 32.2	White tower, 30 feet high, on the N. side of Beach Point, at entrance	●	24	8	1871
CIBOUX ISLAND One rev. *red* lt., 1 min.	46 23.2 60 22.5	On Bird Island, ¼ mile from N. end	●	77	14	1864 1875
Black Rock Point One bright fixed light	46 19. 60 24.	Square white tower, 23 ft. high, on S. side of entrance to Big Bras d'Or	●	45	10	1868
Anconi Point One fixed *red* light	46 19.5 60 17.2	Square white wooden tower, 20 ft. high, on N. side of entrance to Little Bras d'Or Lake ...	●	91	11	1874
SYDNEY 1. One fixed bright lt. 2. One fixed *red* light	46 16.2 60 7.3	1. Tower, 51 ft. high, red and white, vertical, on Flat Point, E. side of Spanish Bay ..... 2. White building, 20 ft. high, on W. end of S.E. bar of the harbour	● ●	70 30	14 9	1832 1872
Bridgeport Harbour One fixed *red* light	46 14.2 60 2.3	On Lingan Head, N. side of entr. to Bridgeport Harbour. Square white tower, 20 ft. high	●	50	10	1874
FLINT ISLAND One bright rev. light	46 11. 59 45.8	White tower, 43 ft. high. Flash every 15 secs.	●	65	12	1856
SCATARI ISLAND One occulting bright lt.	46 2.2 59 40.3	White tower, 70 ft. high, on Trap Rock, at N.E. point. Bright, 1 min.; dark, ½ min. Should not be approached within 2 miles ...	●	90	15	1839
Menadou One fixed *red* light	46 0.5 59 47.5	White tower, 40 ft. high, at W. end of Scatari Island.....	●	90	9	1871
LOUISBURG One fixed bright light	45 54.6 59 57.2	Tower, 35 ft. high, white with black vertical stripes, on N. side of entrance	●	85	16	1842
GUYON ISLAND One rev. *red* lt. ev. ½ m.	45 46.2 60 6.3	Tower, black stripe on white, 54 ft. high, 230 yards within West extreme of island	●	74	12	1877
ST. ESPRIT ISLAND One br. rev. lt., ½ min.	45 37.5 60 29.3	Square wooden tower, 55 ft. high, white, with two red bands. Bad Neighbour Shoal, with 12 ft. on it at low water, lies 1½ mile S.W. ¾ W.	●	78	14	1880
Ouetique Island One fixed *red* light	45 36.7 60 57.3	In Lennox Passage, from square white wooden tower on S. point of island	●	78	9	1874
CAPE ROUND One fixed bright light	45 34.7 60 53.	Square white wooden tower, 28 ft. high, at E. end of Madame Island	●	92	14	1874
Green Island One revolving light	45 28.8 60 53.7	White tower, 31 ft. high, on island near S.E. end of Madame Island. Lt. red and br. for ¾ min. alternately	●	70	14	1865
Petitdegrat Inlet One fixed *red* light	45 29.4 60 57.8	Wooden lighthouse, white, 31 ft. high, on Big Arrow Islet, E. point of entrance to inlet ...	●	38	10	1877
Arichat Harbour One fixed bright light	45 29. 61 1.9	White tower, S. entrance; on Marache Point, Madame Island	●	34	8	1851
West Arichat Harbour One fixed *red* light	45 30.3 61 3.1	White building, 28 ft. high, on N. end of Jerseyman Island. Guide through Crid Passage	●	39	9	1872
Creighton Island One rev. br. lt., 40 secs.	45 30.7 61 6.	At S.W. side of Madame Island; square white wooden tower, 20 ft. high	●	29	10	1874
Canso Harbour One fixed *red* light	45 21. 60 58.5	White building, 28 ft. high, on N.E. part of Hart Island	●	42	9	1872
NOVA SCOTIA.						
SABLE ID., East End One fixed bright light	43 58.5 59 46.	Octagonal tower, 86 ft. high, painted altern. white and brown, 1½ mile from E. end of Id.	2a	128	17	1873
West End One bright rev. light	43 57. 60 8.	Octagonal white tower, 98 ft. high, 17 miles from that on E. end. Shows 3 br. flashes at ½ min. intervals, then eclipsed for 1½ min. ...	●	123	17	1874
Guysboro Harbour One bright fixed light	45 22.8 61 29.2	White tower, 20 ft. high, on W. side of entr., near Peart Point	●	30	8	1846
CAPE CANSO Two fixed bright lights	45 19.8 60 55.5	In one tower, 60 ft. high, striped red and white horizontally, on the N. part of Cranberry Island. Lts. vertical, 12 yds. apart	●	75 40	15 9	1815

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus.	Height above H. W.	Visible in Miles.	Year established.
WHITE HEAD ISLAND	45 12.	White tower, 35 ft. high, on S.W. extremity...	●	55	11	1853
One br. rev. lt., 20 secs.	61 8.					
Whitehaven	45 12.7	Square white wooden lt.-ho., 32 ft. high, on	●	48	11	1879
One fixed bright light	61 9.7	S.E. point of Three-top Id. Light obscured W. of S.W. by W.				
Berry Head	45 11.7	Red and white striped tower, 36 ft. high, on	●	51	10	1876
One fix. *red* or br. lt.	61 18.7	W. side of entrance to Tor Bay; lt. red seaward, bright to northward				
Green Island	45 6.	Square white building, 28 ft. high, on S. point.	●	51	12	1873
One bright fixed light	61 32.5	Guide to Country and Fisherman Harbours				
Isaac Harbour	45 10.3	Shown on Holly Point, 20 ft. apart, vertical,	●	80	9	1877
Two fixed bright lights	61 39.	W. side of entrance to harbour	..	60	..	
WEDGE ISLAND	45 0.6	Approach to St. Mary River and Jegogan Har-	●	71	12	1879
One occulting *red* lt., 3 m.	61 52.6	bour. Square white wooden tower, 44 ft. Light visible 1 min. in every 3 min.				
Liscomb Harbour	44 59.3	On W. side of Liscomb Island, E. side of entr.	●	64	12	1872
One revolving lt., 2 m.	61 57.8	Flashes alternately red and bright				
BEAVER ISLANDS	44 49.6	Tower, 35 ft. high, white, with 2 black balls,	●	70	12	1846
One rev. br. lt., 2 min.	62 20.2	on S.E. pt. of E. Beaver, or William Island				
Sheet Harbour	44 49.9	Square white wooden lt.-ho., 41 ft. high, on	●	75	10	1879
One *red* rev. lt., 40 secs.	62 29.7	Sheet Rock. Lt. shown betw. S.E. $\frac{3}{4}$ E. and S.W. by W. $\frac{3}{4}$ W.				
Pope Harbour	44 47.7	White wooden tower, 37 ft. high, on W. point	●	45	9	1877
One fixed *red* light	62 38.8	of Harbour Island				
EGG ISLAND	44 39.8	Tower, 45 ft., bl. & wh. str. Flashes red & br.	●	85	15	1865
One revolving lt., 1 m.	62 51.5	alternately. Dangerous reefs around it...				
HALIFAX						
Devil Island	44 35.	E. and high lt.-ho., 53 ft. high, E. $\frac{3}{4}$ N., 175 yds.	●	59	13	1852
Two fix. br. leading lts.	63 27.	from low lt.-ho. High lt. E. by N., open S.	●	52	13	1877
		of low lt., leads S. of Thrum Cap Shoal. Pilots				
Sherbrook Tower	44 36.1	On Maugher Beach, E. side of entr. Circular	●	58	10	1815
One fixed bright lt.	63 31.9	tower, 48 ft. high, white, with red roof				
George Island	44 38.	Tower, drab, 21 ft. high, on W. side of Id.; lts.	●	50	12	1876
Two fixed bright lts.	63 33.	20 ft. apart, vertically; open W. of Maugher	●	30	..	
		Beach lt., N. $\frac{1}{4}$ W., lead W. of Thrum Cap				
		Shoal. Two lts. are also shown on Citadel				
		Hill flagstaff, elevated 240 ft				
CHEBUCTO HEAD	44 30.3	White building on the head, W. side of entr.	●	132	18	1872
One br. rev. lt., 1 m.	63 30.8	to harbour				
SAMBRO ISLAND	44 26.2	White tower, 60 ft. high, on middle of island	●	115	17	1758
One fixed bright light	63 33.7					
BETTY ISLAND	44 26.3	White tower, with two red bands	●	75	14	1875
One rev. *red* lt., 2 min.	63 45.8					
St. Margaret's Bay	44 29.	White tower, 26 ft. high, on Peggy's Point, E.	●	65	10	1868
One fixed *red* light	63 57.	side of entrance				
MAHONE BAY						
Green Island	44 23.	Square white wooden tower, 28 ft. high. Lt.	●	59	13	1873
One revolving light	64 2.7	shows br. & red flashes alternately ev. $1\frac{1}{2}$ m.				
EAST IRONBOUND I.	44 26.2	White tower, 46 feet high, on S.E. part of	a	150	16	1867
One fixed bright lt.	64 4.5	island, at entrance of Mahone Bay				1871
Hobson's Nose	44 24.9	White tower, 29 ft. high	●	68	11	1872
One fixed *red* light	64 13.8					
MALAGUASH or LUNENBURG BAY	44 20.	Lts. in one red tower, 52 ft. high, on E. pt. of	●	90	14	1832
	64 7.	Cross Island. Upper lt. bright, 45 secs., dark,		56	8	
One occulting lt., 1 m.		15 secs.				
One fixed bright light						
Battery Point	44 21.7	On the top of a white dwelling house	●	50	10	1864
One bright fixed lt.	64 17.6					
WEST IRONBOUND ID.	44 13.7	White tower, 29 ft. high, on S. side of West	●	70	13	1855
One revol. br. lt., $\frac{1}{2}$ m.	64 16.3	Ironbound Island				
Le Have River	44 17.3	White wooden tower, 35 ft. high, on Fort Point,	●	48	8	1877
One fixed *red* light	64 21.	West side of entrance to river				

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Mosher Island One fixed *red* light	44 14. 64 18.7	White tower, 26 ft. high, on S.E. end of island, on W. side of entrance to Le Have River ...	●	55	10	1868
Metway Head One fixed bright light	44 5.7 64 32.2	Tower, 23 ft. high, white, with black square, on W. side of entrance	●	44	10	1851
LIVERPOOL BAY						
Coffin Island One rev. br. lt., 2 m.	44 2. 64 37.6	Tower, 50 ft. high, red and white bands, on S. point of the island	●	70	16	1812
Brooklyn One fix. br. or *red* lt.	44 2.7 64 41.5	Square white wooden lt.-ho., 33 ft. high, on pier; br. to seaward, red towards harbour...	●	32	10	1878
Fort Point One fixed *red* light	44 3.7 64 39.	Square white building, to be left on the port hand in entering	●	30	5	1855
LITTLE HOPE ISLET One rev. *red* lt., 1 min.	43 48.5 64 47.2	Square white tower, 26 ft. high, on middle of island, to S.E. of the entrance of Port Jolie	●	40	10	1865
Port Mouton One fixed *red* light	43 55. 64 48.	White building, 20 ft. high, on N. point of Spectacle Island	..	47	10	1873
Port L'Hebert One fixed *red* light	43 48.7 64 55.4	White tower, 29 ft. high, at Shingle Beach, E. side of Port L'Hebert	●	33	9	1872
RUGGED ISLAND HARB.	43 39.2 65 5.1					
1. One fixed bright lt.		1. White tower, 39 feet high, on Gull Rock, 2¼ miles S. of harbour entrance.....	●	51	10	1853
2. One fixed *red* light		2. White tower, 29 ft. high, on Carter Island	●	66	9	1872
CAPE ROSEWAY Two fixed bright lights	43 37.2 65 15.7	Vertical, in one tower, 77 feet high, striped black and white vertically, on S.E. point of Mc Nutt's Island, S. of Shelburne.....	● ..	120 65	18 10	1788 1858
Negro Island One revolving lt., 1 m.	43 30.9 65 21.	White tower, 29 feet high, on N.E. side of island. Alternate red and bright flashes ...	●	48	12	1872
Shelburne Harbour One fixed *red* light	43 41.2 65 19.	White building, 20 ft. high, on Sand Point, E. side of harbour	●	67	11	1873
Port Latour One fixed *red* light	43 26.9 65 28.2	Tower, 35 ft. high, white, with black ball, on Baccaro Point, W. side of entrance	●	49	12	1850 1870
Barrington Bay Lt.-Ves. One fixed bright light	43 31.1 65 34.4	Moored in 6 fms., 6¼ miles N.N.W. ¾ W. from Baccaro Pt. lt.-ho. Vessel painted red	●	30	7	1875
CAPE SABLE One br. rev. lt., 40 secs.	43 23.3 65 37.2	White tower, 50 ft. high, on S. pt. of islet, S. of Cape Sable Id. Lt. vis. 15 secs., eclipsed 25 secs.	●	53	12	1861 1870
Shag Harbour	43 28.4	One fixed red lt., on N.W. pt. of Stoddart Id.	●	22	9	1877
Bon Portage Island One rev. *red* lt., 1 min.	43 27.2 65 44.7	Square white wooden tower, 28 ft. high, on S. point of island	●	46	12	1874
Pubnico Harbour	43 35.7	One fixed lt. on Beach Point, S.E. side of entr.	●	28	8	1874
White Head Island One fixed *red* light	43 39.7 65 52.	White tower, 28 ft. high, on S. point of island, to guide vessels into Argyle Harbour	●	115	10	1874
Tusket River Two bright fixed lights	43 42.1 65 57.2	Horizontally, 24 feet apart, on each end of a house, on S.W. pt. of Big Fish Id., at entr.	●	50	12	1864
BAY OF FUNDY.						
SEAL ISLAND One fixed bright light	43 23.6 66 0.9	White tower, 60 ft. high, ⅛ mile inland of South point. Blonde Rock lies 3½ miles to S. by W.	2a	98	18	1830
TUSKET ISLANDS	43 37.6 66 1.7					
1. One occulting *red* or bright light, 1 min.		1. Square white wooden lt.-ho., 42 ft. high, S. pt. of Pease Id., near W. end of extensive shoal off Frenchman Pt. Lt. shows altern. red & br. for 15 secs., at intervals of 45 secs.	●	56	12	1879
2. One fixed *red* light		2. 16 ft. below main lt. Visible betw. S.E. by S. and E. by S. ½ S.	●	40	4	....
CAPE FOURCHU One occ. br. lt., 1¾ m.	43 47.5 66 9.8	Tower, 59 ft. high, striped red and white vertically, on S. point of E. cape. Visible 1¼ min., eclipsed ½ min.	●	117	18	1839
Yarmouth Harbour One fixed *red* light	43 48.5 66 8.7	On a beacon, on reef extending from S.W. pt. of Bunker Id., E. side of entrance. Shown to S. from S.W. by S. to S. ¾ W., and to N.W. from N. ½ W. to N.W. ¼ W.	●	27	8	1874

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CAPE ST. MARY Altern. *red* & br. lt., 30 s.	44 5. 66 10.5	White building, 46 ft. high, on East side of entrance to St. Mary's Bay	●	100	12	1868
Meteghan River One fixed *green* light	44 13.2 66 8.7	On end of breakwater. Lt.-ho. painted in red stripes on seaward side; to be left close to starboard in entering	●	21	6	1875
Church Point One fixed *red* light	44 20. 66 7.5	White tower on point, on E. side of St. Mary's Bay	●	36	8	1874
Sissibou River One bright fixed light	44 26.5 66 1.3	White tower, 33 ft. high, on S. side of entrance to river, E. side of St. Mary's Bay	●	36	8	1871
BRYER ISLAND One fixed bright light	44 14.9 66 23.5	White tower, 55 ft. high, on W. point. S.W. Ledge lies 4 miles to S.S.W. from the light	●	92	15	1809 1832
Peter Island Two fixed bright lights	44 15.5 66 20.9	On white house, at S. entr. to Grand Passage. Lts. horizontal, 8 yds. apart. Shown through the passage to N.N.E., and southward from S.W. by W. to S.S.E. ¼ E.	● ●	40 ..	10 ..	1850
Petit Passage One revolving lt., 1 m.	44 24.3 66 13.	Light white and red alternately; on house on Boar's Head, S. side of N. entrance. Shown from E. by S. to S.W. by W.	●	70	10	1864
DIGBY, or ANNAPOLIS One fixed bright light	44 41.8 65 47.3	Tower, 22 ft. high, striped vertically, on Point Prim, S. pt. of entrance to Annapolis Basin	●	76	13	1817
Marshall Cove Two fixed bright lights	44 56.9 65 16.	Vertically, on end of pier at Fort Williams, 21 ft. apart. Shown northwards, from W.S.W. to E.N.E.	●	92 70	10 ..	1859
Margaretville Two fixed *red* lights	45 2.9 65 4.	Square building, black and white bands. Lts. vertical	●	30 27	8	1859
BLACK ROCK POINT One fixed bright light	45 10.2 64 46.	White tower, 35 ft. high	●	45	12	1848
Kingsport One fixed bright light	45 9.5 64 21.7	Lt.-ho., 26 ft. high, lower part open framework, brown, upper part enclosed, white, on pier, W. side Cornwallis R., Basin of Mines. Lt. vis. betw. N.E. ½ E. and S.E. by E. ¾ E.	●	30	8	1879
Horton One fixed bright light	45 6.3 64 13.2	White tower, 20 ft. high, on the bluff; on W. side of entrance of River Avon	●	92	15	1851
Walton Harbour One fixed *red* light	45 14. 64 0.8	White building, 20 feet high, on N. side of entrance	●	60	10	1873
Burnt Coat Head One bright fixed light	45 18.3 63 48.5	Square white tower, 50 ft. high, on S. side of entrance to Cobequid Bay, Basin of Mines...	●	75	13	1859
Spencer Point One bright fixed light	45 23.5 63 36.	On the N. side of Cobequid Bay. Shown from a window in a building	●	35	6	1863
Parrsborough One fixed bright light	45 23. 64 19.	White tower, 32 ft. high, on Partridge Island, W. side of river	●	37	9	1852
ISLE HAUTE One inter. br. lt., 1 m.	45 14.9 65 0.7	Square white wooden lt.-ho., 53 ft. high, almost hidden by trees. Lt. vis. 40 secs. in ev. min.	●	365	20	1879
Apple River One fixed bright light	45 28.3 64 51.5	White house, on Cape Capstan, or Hetty Point	●	64	10	1848
Grindstone Island One fixed bright light	45 43.2 64 37.4	White tower, on W. part of Id., in Chignecto Channel	●	60	12	1859
Hillsborough	45 55.3 64 37.8	Beacon lt. from tower, 22 ft. high, on wharf, Petit Coudiac River	●	14	5	1876
CAPE ENRAGE' One fixed bright light	45 35.6 64 46.9	Octagonal white tower, 23 ft. high, on pitch of the cape. Shown from N.W. to N.E.	●	121	15	1840
QUACO One rev. br. lt., 20 secs.	45 19.3 65 31.9	Tower, 46 ft. high, red and white horizontal bands, on rock off the head	●	58	15	1835
CAPE SPENCER One revolving lt., 1½ m.	45 12.1 65 55.	Square white building, 35 ft. high. Flashes alternately red and white	●	207	20 10	1873
ST. JOHN HARBOUR Partridge Island One fixed bright lt.	45 14.1 66 3.1	Tower, 40 ft. high, striped vertically red and white	●	119	16	1791 1832

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
ST. JOHN HARBOUR—*(continued).*						
Negro Point One fixed *red* light	45 14.3 66 3.3	White lt.-ho., 35 ft. high, 50 ft. within extr. of breakwater running out 720 yds. S.S.E. from Negro Point. (Lt.-house destroyed. When practicable, a red lt. will be shown from beacon pole at extremity of breakwater works)	●	36	8	1878
Beacon Tower One fixed bright lt.	45 15.1 66 3.1	Striped vertically, white and black, on South extreme of Spit, West side of harbour.....	4a	35	10	1828 1868
Musquash Harbour One fix. *green* or br. lt.	45 8.6 66 14.5	Square white wooden lt.-ho., 40 ft. high, E. side of entr. Lt. shows green to seaward, and bright towards the harbour.....	●	112	10	1879
POINT LEPREAU Two fixed bright lights	45 3.5 66 27.6	Tower, 31 ft., red & white bands; lts. vertical, 28 ft. apart. Shown from W.N.W., southward, to E. by N.	●	81 53	15	1831
Beaver Harbour One fixed bright light	45 3.7 66 44.0	White tower, 36 ft. high, on Drew Point, W. side of harb.; lt. vis. to southwd. betw. heads of harb. Good anchorage E. by N. from it	●	45	10	1876
SOUTH WOLF ISLAND One br. rev. lt., 1½ m.	44 56.5 66 44.2	White lighthouse, 35 ft. high, on S.E. point of island	●	111	18	1872
L'Etang Harbour 1. One fixed *green* light 2. One fixed *red* light	45 2.3 66 48.7	1. White lt.-ho., 31 ft. high, on W. extr. of Pea Island, E. side of entrance to harbour... 2. White tower, 30 ft. high, on W. pt. of Bliss Island, in the entrance of the harbour.....	● ●	51 45	16 10	1878 1872
CAMPOBELLO ISLAND One fixed bright light	44 57.7 66 54.2	Tower, 34 ft. high, white, with red cross, on N. point of Head Harbour	●	64	15	1829
Passamaquoddy Bay One fixed bright light	45 7. 66 54.5	White wooden tower, 29 ft. high, on Mijic Bluff, at entrance of Magaguadavic River. Shoal extends 250 yds. E.N.E. of lt.-house...	●	130	15	1876
Port St. Andrew 1. One fixed br. lt. 2. One fixed br. lt.	45 4.2 67 4.	1. White tower, 22 ft. high, on N. pt. of entr. 2. White frame tower on Tongue Shoal, 1½ m. S.E. by E. from Port St. Andrew light	● ..	42 40	10 10	1833 1876
St. Croix River Two fixed bright lts.	45 10. 67 10.	On Spruce Point and St. Mark Point, N. side of river. Square white towers, 28 ft. high...	● ●	32 32	.. ..	1876 1876
GREAT MANAN ISLAND One fixed bright light	44 45.9 66 44.1	White tower, 50 ft. high, on N.E. point of Id. Shown eastward, from S.W. to N.W.	●	148	17	1861
Grand Harbour One fixed bright lt.	44 40. 66 45.5	Square white wooden lt.-ho., 32 ft. high, on Fish Fluke Point, E. side of harbour. Vis. from South, through West, to N.E.	●	40	11	1879
SOUTH-WEST HEAD One flash. *red* & br. lt.	44 36. 66 54.3	Square white wooden tower, 43 ft. high, on Gull Cliff. Lt. makes a complete revolution in 2 min., showing 3 br. and 3 red flashes, with intervals of 20 secs. eclipse	●	200	20 10	1880
MACHIAS ISLANDS Two fixed bright lights	44 30.1 67 6.2	White towers, on East Id. Lts. in one, N.W., clears Murr Ledges 4 miles to southward ...	3a 2a	66 58	14 ..	1832 1878
GANNET ROCK One fix. & fl. br. lt., 1 m.	44 30.6 66 47.	Tower, 41 ft. high, striped black and white, vertically; fix. 45 sec., ecl. 5 sec., flash 5 sec., ecl. 5 secs. Reefs extend 4 miles to eastward	4c	66	12	1831 1867
MAINE.		**UNITED STATES.**				
St. Croix River One fix. & fl. br. lt., ½ m.	45 7.7 67 8.	White house on Dochet Island, opposite red beach.....	5c	71	12	1856
WEST QUODDY HEAD One fixed bright light	44 48.9 66 57.	Tower, 55 ft., red & white bands, near Eastport, S. side of entr. Shown from N. 63° W. to S. 57° W.	3a	133	17	1808 1858
Little River One fixed & flashing lt.	44 39.8 67 12.1	Red tower, 28 ft. high, on Id., at entr. Flash every 1½ min. Shown from N. 63° E. to S....	5c	40	12	1855 1876
Machias Bay One fixed *red* light	44 39. 67 21.	White tower, 36 ft. high, on S. end of Avery Rock	5a	68	14	1875
Libby Island One fixed bright light	44 34.1 67 22.	Gray tower, 35 ft. high, on island, entrance to Machias Bay.....	4a	52	13	1822 1876
MOOSE PEAK One rev. br. lt., 30 secs.	44 28.5 67 31.9	White tower, 40 ft. high, on Mistake Island, S. of Moose Peak, or Moose-a-bec Island ...	2b	65	14	1826 1856
Nash's Island One fixed *red* light	44 27.8 67 44.8	White tower, 28 ft. high, on E. side of Pleasant River	4a	47	12	1838 1873

Name and Character of Light.	Lat. N. Long. W. ° '	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Narraguagus Bay One fixed bright light	44 28. 67 49.8	White tower, 29 ft., on S.E. point of Pond Id. Shown eastward, from N. ½ E. to S.W. by S.	5a	45	12	1856
PETIT MANAN One fixed and flash. lt.	44 22. 67 51.8	Gray tower, 109 ft. high, on S. end of island. Flash every 2 minutes. Dangerous rocks lie from 2 to 5 miles off	2c	125	17	1855
Prospect Harbour One *red* & br. rev. lt., ½ m.	43 24.2 68 0.8	From old light-tower on East entrance point. Flashes red and white alternately	5b	40	11	1870
Winter Harbour One fixed bright light	44 21.7 68 4.9	On S. point of Mark Island, Frenchman Bay. Shown from N. by E. ¼ E. to N. by W. ¼ W.	5a	37	11	1856
Frenchman Bay One fixed *red* light	44 21.3 68 8.	White tower, 56 feet high, on highest part of Egg Rock	5a	76	14	1875
MOUNT DESERT One fixed bright light	43 58. 68 7.7	Gray tower, 60 ft. high, on the rock	3a	75	14	1857
BAKER'S ISLAND One fix. and flash. br. lt.	44 14.4 68 11.9	White tower, 37 ft., on islet S. of Little Cranberry Id., off Mount Desert Id. Flash ev. 1½ m.	4c	105	15	1855
Bear Island One fixed bright light	44 17. 68 16.2	Red tower, 22 ft. high, on Cranberry Island, entrance of Soames Sound	5a	97	15	1839 1856
Bass Harbour Head One fixed *red* light	44 13.3 68 20.2	White tower, 26 ft. high, E. side of entrance, S. end of Mount Desert Island	5a	56	13	1858
Burnt Coat Harbour Two fixed bright lights	44 8. 68 27.	White towers, 32 and 17 ft. high, at entrance of Refuge Harbour, Swan Island. Beacon lts. in one, N.E. ¾ N., 100 ft. apart, lead in	4a 5a	75 42	14 10	1872 ....
Fly, or Green Island One fixed bright light	44 14.9 68 29.9	White tower on S.E. point of island, in S.E. entrance to Edgemoggin Reach	5a	26	9	1856
SADDLEBACK LEDGE One fixed bright light	41 0.8 68 43.6	Tower, 36 ft. high, lower part white, on S.W. end of island, in entr. of Isle au Haut Bay	5a	51	13	1839 1856
PENOBSCOT BAY						
Heron Neck One fixed *red* light	44 1.5 68 51.4	White tower, 24 ft. high, on S. pt. of Green's Id., at S.E. side of entr. to Penobscot Bay	5a	92	14	1853
Deer Island Pass One fixed bright lt.	44 8.1 68 41.9	White tower on Mark Island, Isle au Haut Bay	4a	52	12	1857
Eagle Island One fixed bright lt.	44 13.1 68 45.7	White tower, 30 ft. high, N. point of Id., N.E. entr. to Penobscot Bay, from Isle au Haut Bay	4a	106	15	1837
Pumpkin Island One fixed bright lt.	44 19. 68 45.	On Id. off N.W. end of Little Deer Id., N.W. end of Edgemoggin Reach. Guide to Buck Harb.	5a	27	9	1854
MATINICUS ROCK Two fixed bright lts.	43 47. 68 51.	Gray towers, 40 and 50 ft. high, N.N.W. and S.S.E., 60 yards apart	3a	90 85	15	1857
Whitehead Island One fixed bright lt.	43 58.7 69 7.1	Gray tower, 34 ft. high. Shown from North to W. ½ S.	3a	79	13	1856
OWL'S HEAD One fixed bright lt.	44 5.5 69 2.3	West side of entr. to Penobscot Bay. Shown from N. 76° W. to S.S.W.	4a	100	16	1825 1856
Brown's Head One fix. br. or *red* lt.	44 6.7 68 54.2	White tower on South Fox Id. A sector of red lt. is shown through an arc of 12° 35′, betw. S.W. by W. ¾ W. and W. by S. ¼ S., nearly, defining channel betw. Fiddler's Ledge on the N., and Bay Ledges on the S., both to be cleared by keeping within the red sector	5a	39	12	1856 1880
Rockport Harbour One fixed *red* light	44 10. 69 3.	Square brick building, painted white, on Indian Island	5a	42	11	1875
Negro Island One fixed bright lt.	44 12.1 69 2.6	White tower, 23 ft. high, S. side of entrance to Camden Harbour	4a	52	12	1835 1856
Grindels Point One fixed bright lt.	44 16.9 68 56.2	White tower, 28 ft. high, on N. side of Gilkey Harbour, Long Island	5a	39	11	1850
Dice's Head One fixed bright lt.	44 22.9 68 48.8	White tower, 42 ft. high, near Castine, North side of entrance to harbour	4a	130	17	1858
Fort Point One fixed bright lt.	44 28. 68 48.4	On W. side of entrance to Penobscot River	4a	103	16	1857
Tennant's Harbour One rev. *red* lt., 1 min.	43 57.6 69 10.3	N.E. side of S. Island. Shown from E. by N. ¼ N. to S.W. ¼ S.	5a	66	13	1867

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Marshall's Point One fixed bright light	43 55. 69 15.3	At entrance to Herring-gut Harbour. Shown from E. ¾ N. to N. by the East and South ...	5a	31	10	1857
MANHEIGAN ISLAND One rev. br. lt., 1 min.	43 45.9 69 18.6	Gray tower, 36 ft. high, on S. side of island ...	2b	175	19	1851
Franklin Island One fix. and flash. br. lt.	43 53.5 69 22.2	North end of island, West side of entrance to St. George's River. Flash every 1½ minute	4c	54	12	1855
PENMAQUID POINT One fixed bright light	43 50.2 69 30.	White tower, 32 ft. high, at S.W. entrance to Bristol Bay. Shown from N.E. ¼ N. to N., by the East and South	4a	75	14	1857
Burnt Island One fixed bright light	43 49.5 69 38.1	West side of entrance to Townsend Harbour. Shown from N. by E. to S.S.W.....	4a	61	13	1821 1858
Hendrick's Head One rev. br. lt., ½ min.	43 49.3 69 41.1	White tower, 30 ft. high, on E. side of Sheepscott River. Guide to Wiscassett. Shown from S. by E. ¼ E. to N. by E. ¾ E.	4b	40	12	1829 1875
Pond Island One fixed bright light	43 44.4 69 45.9	On W. entr. of Kennebec River. Shown from N.W. ½ W. to S.W. by W. ½ W.....	5a	54	13	1855
SEGUIN ISLAND One fixed bright light	43 42.4 69 45.2	Gray tower, 35 ft. high, on island off entrance to Kennebec River.....	1a	180	20	1795 1857
PORTLAND, or CASCO BAY						
HALFWAY ROCK One fixed & flash. lt.	43 39.3 70 2.2	Gray tower, 66 ft. high, on rock off N.E. entr. to Casco Bay. Bright fixed lt., with red flash every minute	3c	75	15	1871
CAPE ELIZABETH One rev. br. lt., 1 m. One fixed bright lt.	43 33.9 70 11.7	Eastern tower, 53 ft. high (fix. lt.), W. tower, 53 ft. high (revolving light), both painted brown, 300 yds. apart. Shown from N. to S.W. by W. ¾ W.	2b 1a	143 143	18 ..	1828 1874
PORTLAND HARBOUR One fixed bright lt.	43 37.4 70 12.1	White tower, 69 ft. high, on the head, S. side, near entrance	2a	101	14	1790 1864
Portland Breakwater One *red* fl. lt., 15 secs.	43 39.3 70 13.8	On N.E. end. Shown from S.W. ¾ W. to S.S.E. ½ E.....	5c	23	8	1855
Wood Island One rev. *red* lt., 1 min.	43 27.4 70 19.4	White tower, 47 ft. high, near Saco Harbour. Guide to Winter Harbour	4b	62	13	1858
Goat Island One fixed bright light	43 21.4 70 25.2	White tower, 25 ft. high, on N. side of mouth of Cape Porpoise Harbour. Shown from N.E. ¾ E. to N., by the South and East	6a	38	11	1833 1857
CAPE NEDDICK One fixed *red* light	43 9.7 70 35.5	Conical iron lt.-ho., 40 ft. high, painted red, lantern black, on York Nubble	4a	92	15	1879
BOON ISLAND One fixed bright light	43 7.3 70 28.2	Gray tower, 123 ft. high, on W. part, off York Harbour.....	2a	133	17	1812 1854
NEW HAMPSHIRE.						
Whale's Back One fix. and flash. br. lt.	43 3.5 70 41.5	White tower, 40 ft. high, on N.E. side of outer entrance to Portsmouth Harbour. Flash ev. 1½ min.	4c	58	12	1829 1855
Portsmouth One fixed bright light	43 4.2 70 42.2	White tower, 60 ft. high, on S.W. side of inner entr. of harb. Shown from W.N.W. to S.W.	4a	70	14	1804 1854
ISLES OF SHOALS One revolving lt., ½ min.	42 58. 70 38.2	White tower, 40 ft. high, on White Id.. S.W. Id. of Is. of Shoals. Flashes red & br. alternately	2b	87	15	1821 1858
MASSACHUSETTS.						
Newbury Port 1. Two fixed bright lts. 2. Two fixed lights, *red* and *green*	42 48.5 70 48.7	1. Upper lt., a white tower, 38 ft. high, S. side of entr. to port. Shown from S. by E. to W. by S. Lower shifting bcn. lt., 350 ft. in front 2. Leading lts. after entering; in one, W. ½ S., 116 yds. apart	5a ● ● ..	54 25 47 25	13 8 10 ..	1809 1869 1873 ....
Ipswich Harbour One fix. & flash. br. lt. One fixed bright light	42 41.1 70 45.6	White tower, 30 feet high, on South side of entrance. Fix. lt., with flash every 1½ min. Beacon lt., fixed, 500 ft. in front, frequently shifted. In one, lead in	4c ●	46 20	12 8	1837 1859
Annisquam Harbour One fixed bright light	42 39.7 70 40.6	White tower, 34 ft. high, on Wigwam Pt., E. side of entrance. Shown from S.W. by S. ½ S. to S.E. by E. ½ E.	5a	50	12	1801 1857
Straitsmouth Harbour One fixed bright light	42 39.7 70 34.9	On island, N. of Cape Ann. A local light for Rockport and channel inside the Salvages. Shown eastward, from W. ¾ N. to S. ¾ W....	6a	33	10	1850

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CAPE ANN	42 38.3	Two stone towers, each 112 ft. high, on Thatcher's Id., N. by E. ¾ E. and S. by W. ¾ W.,	1a	165	20	1790
Two fixed bright lights	70 34.2	298 yds. apart	1a	165	20	1861
Gloucester Harbour	42 34.6	White tower, 33 ft. high, on the Eastern Head.	4a	60	13	1837
One fixed *red* light	70 39.5	Shown from E. ½ N. to N. ½ W.				1857
Ten Pound Island	42 36.1	White tower, 33 ft. high, on Id. in Gloucester,	6a	49	12	1821
One fixed bright lt.	70 39.6	or Cape Ann Harbour				1850
SALEM						
Baker's Island	42 32.2	Two white towers, 52 & 29 ft. high, S. side of	4a	87	15	1797
Two fixed bright lts.	70 46.8	N.E. entr. to Salem Harbour, 13 yds. apart. In one, N.W., clears S.E. breaker	..	64	13	1857
Hospital Point	.....	N. side of Salem Harb. Dangers lie to S. & W.	3a	63	13	1871
One bright fixed lt.		of this, in line with the high lt. on Baker's Id. The lt. is brightest in the fairway channel				
Winter Island	.....	Red iron tower near Fort Pickering. In range	5a	25	8	1871
One bright fixed lt.		with Derby Wharf lt., clears Haste Shoal				
Derby Wharf	.....	Red light on the end of the wharf	5a	15	5	1871
Marblehead Harbour	42 30.3	White tower, 23 ft. high, S. side of entr. Shown	6a	43	12	1835
One fixed bright light	70 49.7	from N. by W. ¾ W., by the E., to W. by S. ¼ S.				1856
Egg Rock	42 26.	On a house to E.N.E. of Nahant	5a	87	12	1856
One fixed *red* light	70 53.5					
BOSTON BAY						
OUTER MINOTS LEDGE	42 16.1	Gray granite tower, 100 ft. high, on one of the	2a	92	14	1860
One fixed bright lt.	70 45.5	Cohasset Rocks				
BOSTON	42 19.6	White tower, 80 ft. high, on Little Brewster	2b	111	17	1784
One rev. br. lt., ½ m.	70 53.4	Island, North entrance of harbour				1859
Narrows	42 19.3	Pile lt.-ho., on W. end of Spit from Brewster	5a	46	12	1856
One fixed *red* light	70 55.2	Island. In one with Long Island Head lt., clears Harding's Ledge				
Long Island Head	42 19.8	White tower, 27 ft. high, on N.E. end of island	4a	121	15	1819
One fixed bright lt.	70 57.4					1855
CAPE COD BAY						
Plymouth	42 0.2	Two white towers, 34 ft. high, on Gurnet Pt.,	4a	102	11	1769
Two fixed bright lts.	70 35.7	N. side of harb. In one, N.W., 10 yds. apart. Shown from N.N.W. to W.N.W.	..	..	6	1856
Duxbury	42 2.	Red tower, 31 ft. high, near Pier	5a	47	10	1816
One bright fixed lt.	70 40.					1871
Race Point	42 3.7	Red iron tower, on N.W. point of Cape Cod.	4c	51	11	1816
One fix. & flash. br. lt.	70 14.3	Flash every 1½ minute				1875
Long Point	42 1.9	On shoal, S.W. entr. to Provincetown Harbour.	5a	37	11	1826
One fixed bright lt.	70 9.8					1874
Provincetown Harbour	42 1.	Dark-brown brick tower, 41 ft. high, at Wood	5c	41	11	1872
One flash. *red* lt., 15 s.	70 11.	End, near entrance				
Mayo's Beach	41 55.8	Head of Wellfleet Bay. Shown from S. ¼ W.	●	36	10	1838
One fixed bright lt.	70 1.7	to S.W. ¼ W.				1856
Billingsgate Island	41 52.3	Red tower, 34 ft. high, on W. side of entrance	4a	52	12	1822
One fixed bright lt.	70 3.8	to Wellfleet				1858
Sandy Neck	41 43.3	White tower, 44 feet high, on West side of	4a	59	11	1836
One fixed bright lt.	70 17.1	entrance to Barnstaple. Shown from W. by S. ¾ S. to S.W. by S. ¼ S.				1857
CAPE COD HIGHLANDS	42 2.3	White tower, 55 ft. high, on Cape Truro, East	1a	195	20	1797
One fixed bright light	70 3.6	side of Cape Cod. Shown from S.W. to S.				1857
Nauset Beach	41 51.6	Three white buildings at Eastham, E. side of	4a	93	10	1837
Three fixed bright lts.	69 56.7	Cape Cod. N. and S., 50 yds. apart. Shown from N.W. to S. by E.				1856
Chatham Harbour	41 40.3	White towers, each 46 ft. high, on W. side.	4a	80	14	1808
Two fixed bright lights	69 56.6	N. and S., 33 yards apart. Shown from N. by E. to W. by N.				1877
Monomoy Point	41 33.5	Red iron tower, 30 ft. high, on Cape Malabar,	4a	38	10	1823
One fixed bright light	69 59.3	S. end of Cape Cod				1857

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Pollock Rip Lightvessel Two fixed *red* lights	41 32.1 69 55.1	Painted red; off Chatham, 4 miles E.½ S. from Monomoy lt.	●	45	12	1849 1879
Shovelful Lightvessel One fixed *red* light	41 34. 69 59.2	Painted green, 1⅝ mile S. by W. from Monomoy Point	●	40	11	1852
Handkerchief Lt.-Vessel One fixed bright light	41 39.6 70 3.3	Schooner-rigged, straw colour. In 5¼ fathoms, 1½ mile from S. part of shoal	●	40	10	1855
Stage Harbour One fixed bright light	41 39.3 69 59.	Lt.-ho., 35 ft. high, painted red, with black lantern, on Harding's Beach. Lt. is visible through an arc of 270°	4a	41	..	1880
Bishop and Clerks One rev. br. lt., ½ min.	41 34.4 70 14.7	Gray tower, 47 ft. high, on N. part of shoal	4b	59	13	1858
Succonnesset Shoal Lt.-V. One fixed bright light	41 32. 70 26.7	Schooner-rigged, with red and white squares. In 6 fathoms. Between Succonnesset and Eldridge Shoals	●	40	10	1864
NANTUCKET One fixed bright light	41 23.4 70 2.4	White tower, 60 ft. high, on N.E. point of Id. Shown from S. by W. ½ W. to S.E. by E.	3a	70	14	1784 1857
SANKATY HEAD One fix. and flash. br. lt.	41 17. 69 57.6	Tower, 65 ft. high, white, red, white, on S.E. part of Nantucket Island. Flash of 10 secs. every minute	2c	150	20	1849
South Shoal Lightvessel Two fixed bright lights	40 56. 69 51.5	Schooner-rigged, red. In 14 fathoms. Two miles S. of shoal	●	44	12	1858
VINEYARD SOUND						
Hyannis Harbour One fixed *red* light	41 38. 70 17.	White building, inside the breakwater. Shown from S. by E. ½ E. to W.S.W. ¼ W	●	42	10	1849
Cross Rip Lt.-Vessel One fixed bright lt.	41 26.7 70 17.1	Black, with white streak. In 8 fathoms, N.W. of Nantucket	●	39	10	1828 1864
Nantucket Cliff Two fixed bright lts.	41 17.6 70 6.4	On the beach, N.W. of harbour, N.W. and S.E. 100 yards apart	● ●	8 10	7 ..	1838 1856
Brant Point One bright fixed lt.	41 17.3 70 5.2	Red tower, 42 ft. high, on W. point of entr. to Nantucket Harbour	4a	46	12	1759
Cape Poge One fixed bright lt.	41 25.2 70 26.7	White tower, 36 ft. high, on N.E. pt. of Martha's Vineyard Island	4a	57	13	1801 1857
Edgartown One fixed bright lt.	41 23.4 70 29.8	On N.W. side of entrance to harbour. Shown from S.W. by W. to S. by W.	4a	37	12	1828 1856
Holmes Hole 1. One fix. bright lt. 2. One fixed *red* lt.	41 28.9 70 36.	1. White tower, 33 ft. high, on W. Chop of harbour. Shown from W. by N. ½ N. to S. ¾ E. 2. White iron lt.-ho. on E. Chop, E. entr. pt. of harbour. Lt. shown between E.S.E. and W. by S.	4a 4a	69 77	13 14	1817 1876
Nobsque Point One fixed bright lt.	41 30.9 70 39.	Red tower, E.S.E. of entrance to Wood's Hole Harbour. Shown from N.E. by N. to ¼N.W. by W.	5a	89	13	1828 1876
Tarpaulin Cove One fix. & flash. br. lt.	41 28.1 70 45.1	White tower, 32 ft. high, on West side, on Naushon Island. Flashes every ½ minute. Shown from N. to W.	5c	80	13	1817 1870
Vineyard Sound Lt.-V. Two fixed bright lts.	41 22. 70 58.7	Painted red, with yellow streak. In 13½ fms., near Sow and Pigs Rocks. Two red balls	● ..	34 23	9 ..	1847 1855
Hen & Chickens Lt.-V. One bright fixed lt.	41 27. 71 0.8	Gooseberry Point. Painted lead-colour; in 10 fms., 1 mile S.E. of reef	●	25	10	1864
GAY HEAD One flashing *red* and bright light	41 20.9 70 49.8	Red tower, 41 ft. high, on W. pt. of Martha's Vineyard Island. Flash ev. 10 secs., every fourth flash being red. A rocky shoal to N.W., 1½ mile	1b	170	20	1799 1858
BUZZARD'S BAY						
Cuttyhunk One fixed bright lt.	41 24.8 70 56.6	White tower, 32 ft. high, on S.W. point of Id. Shown from S.E. by S. ½ S. to N.E. by E. ½ E.	5a	42	12	1823 1857
Dumpling Rock One fixed bright lt.	41 32.3 70 54.9	White tower, 32 ft. high, off Round Hill. Shown from N.W. by N. to S.W. by W.	5a	42	12	1828 1857
NEW BEDFORD One bright fixed lt.	41 35.7 70 53.8	On N.W. angle of Fort, Clark's Point, W. side of entrance. Shown from N. by E. ¼ E. to W. by N. ¼ N.	5a	68	13	1800 1862

Name and Character of Light.	Lat. S. Long. E. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
BUZZARD'S BAY—*(continued).*						
Palmer's Island One fixed bright lt.	41 37.6 70 54.2	On N.E. end, in New Bedford Harbour.	5a	32	9	1849 1856
Ned's Point One fixed bright lt.	41 39. 70 47.4	White tower, 32 ft. high, on E. side of Mattapoisett Harbour. Shown from S.E. ¾ E. to S. by W. ¼ W.	6a	43	11	1849 1856
Bird Island One fix. & flash. br. lt.	41 40.1 70 42.7	East side of entrance to Sippican Harbour. Flash every 1½ minute	5b	35	10	1819 1857
Wing's Neck One fixed bright lt.	41 40.8 70 39.3	Head of Buzzard's Bay, in Sandwich. Shown from S.E. ½ E.. to N.E. ½ N.	5a	44	10	1849 1856
RHODE ISLAND.						
Brenton's Reef Lt.-Ves. Two fixed bright lights	41 25. 71 21.5	Painted straw colour. In 15 fathoms, E. side of entrance to Newport.....	●	50 40	12	1850
BEAVER TAIL One fixed bright light	41 26.9 71 23.6	Square granite tower, 74 ft. high, on S. point of Conanicut Id., entr. to Newport Harbour. Shown from N.E. ¾ E. to N.W. ¾ W.	3a	68	13	1793 1856
Lime Rock One fixed *red* light	41 28.6 71 19.2	On the rock, S. side of Newport Harbour	6a	30	9	1854
NARRAGANSETT BAY						
Newport Harbour One fixed bright lt.	41 29.6 71 19.3	On North end of Goat Island	4a	33	11	1823 1857
Rose Island One fixed *red* light	.....	On S.W. point of the island.....	6a	58	11	1869
Dutch Island One fixed bright lt.	41 29.8 71 23.9	White tower, 35 ft. high, on S. end of island...	4a	56	14	1826 1875
Wickford One fixed bright lt.	41 34.2 71 26.	White tower, 33 ft. high, on Poplar Point. Shown from N.E. by E. ½ E. to S. ½ E.	5a	51	12	1831 1855
Prudence Island One fixed bright lt.	41 36.3 71 17.9	White tower on East side, on Sandy Point. Shown from N. by W. to S.S.W.	5a	30	10	1852
Bristol Ferry 1. One fixed br. lt. 2. One fixed *red* lt.	41 38.5 71 15.2	I. On N. side of entrance to Mount Hope Bay. Shown from N.E. to S.W. ..... 2. On beacon on Mussel Shoal, S.E. side of channel	6a 6a	35 37	10 9	1855 1873
Warwick One fixed bright lt.	41 40. 71 22.4	On S. end of neck. Shown from N.E. by N. to W.N.W.	4a	54	14	1826 1876
Providence River One fixed bright lt.	41 42.5 71 21.	Granite tower, 50 ft. high, on end of spit of Conimicut Point, West side of entrance of river. Shown from N.N.W. to S.W. Above this, five fixed lights are shown in Providence River	4a	50	11	1868
POINT JUDITH One rev. br. lt., 15 secs.	41 21.6 71 28.6	White tower, 45 ft. high, on S. extremity of Narragansett shore. Shown from W. by S. to N.N.E.	4a	67	14	1810 1857
BLOCK ISLAND 1. One fixed bright lt. 2. One fixed bright lt. 3. Two fixed *red* lights	41 13.6 71 34.6	I. Gray granite tower, 50 ft. high, on N. pt. of Id. Shown northwards, from S.S.W. to S.S.E. ..... 2. On S.E. end of Id. Brick tower, 67 ft. high 3. Leading lights for anchorage near the breakwater on the East side of the island ...	4a 1a ..	75 200 ..	12 21 ..	1829 1869 1875 1880
WATCH HILL One fixed bright light	41 18.2 71 51.8	Granite tower, 40 ft. high, on Watch Point, 3 miles S.E. of Stonington. Shown southwards, from W. ¾ N. to E. ¾ N.	4a	62	14	1808 1857
CONNECTICUT AND NEW YORK.						
BLOCK AND LONG ISLAND SOUNDS.						
Stonington One fixed bright lt.	41 19.6 71 54.	White tower, 30 ft. high, on E. side of entr. Shown from S.S.E. to W.	6a	60	12	1823 1875
Eel Grass Lightvessel One fixed bright lt.	41 18.4 71 56.7	On the shoal, painted lead colour	●	32	10	1835 1857
Morgan's Point One fixed bright lt.	41 18.9 71 59.1	Granite tower, 34 ft. high, on North side of Fisher's Island Sound. Shown from S.S.W. to N. by E.	6a	61	11	1831 1867

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
BLOCK AND LONG ISLAND SOUNDS—*(continued)*.						
North Dumpling Id. One fixed *red* light	41 16. 72 3.	In Fisher's Island Sound	6a	70	12	1855 1868
NEW LONDON One fixed bright lt.	41 19.1 72 5.	White tower, 83 ft. high, on West side of entrance to River Thames. Shown eastward, from N. ½ W. to W. ½ S.	4a	86	14	1800 1875
Bartlett's Reef Lt.-Ves. Two fixed bright lts.	41 16. 72 7.5	On reef, off New London. Painted black with white streak; two masts	● ..	28 35	10 ..	1846 1857
LITTLE GULL ISLAND One bright fixed lt.	41 12.3 72 6.7	Granite tower, 74 ft. high, on S. side of main entr. betw. Block and Long Island Sounds. Shown from W.S.W., by North, to S.W.	2a	92	16	1806 1870
RACE ROCK Revol. *red* and br. lt. every 30 secs.	41 14.6 72 2.8	Lt.-ho., surmounted by black lantern, off W. extr. of Fisher Id., N. side of entr. to Long Island Sound	4b	66	14	1878
Gardiner's Island One fixed bright lt.	41 8.3 72 8.2	On N. point. Shown northward from S. ½ W. to S.E. ¼ S.	6a	29	8	1855
Plum Island One rev. br. lt., ½ m.	41 10.4 72 13.6	White tower, 34 ft. high, on W. end, N.E. extr. of Long Island. Guide through Plum Gut...	4b	76	12	1827 1869
Long Beach Bar One fixed *red* light	41 6.3 72 17.8	Pile lighthouse, in 5 ft. water, at entrance to Orient & Greenport Harbours, Long Island	5a	56	13	1871
Cedar Island One fixed bright lt.	41 2.4 72 15.3	White tower, 31 ft. high, at entrance to Shag Harbour, Long Island	6a	45	10	1839 1869
Saybrook Point One fixed bright lt.	41 16.3 72 20.3	White tower, 70 ft. high, on Lynde Point, W. side of mouth of Connecticut River. Shown southward from W. by S. to N. by W.	4a	80	13	1803 1857
Calves' Island One fixed bright lt.	41 19.5 72 21.	Two miles below Essex Town, E. side of river	6a	..	3	1856
Brockways Reach	.....	Fixed bright lt., 2 miles above Essex Town	6a	..	3	1856
Devil's Wharf	.....	Fixed bright lt., 4 miles above Essex Town	6a	..	3	1856
Cornfield Point Lt.-Ves. One fixed *red* light	41 13.5 72 22.8	Red; sloop-rigged. In 7½ fathoms, on middle of S. side of Long Sand Shoal	●	40	10	1856
HORTON'S POINT One fixed bright lt.	41 5.1 72 26.4	White tower, 30 ft. high, on the point. Shown northward from S.W. by W. to N.E. by E.	3a	110	18	1857
FAULKNER'S ISLAND One fix. & flash. br. lt.	41 12.7 72 38.9	White tower, 44 ft. high, on island off Guilford Harbour. Flash every 1½ min. Shown all round	4c	98	15	1801 1856
NEW HAVEN HARB. One fixed bright lt.	41 14. 72 54.8	From one-storied dwelling on S.W. Ledge, at entrance of harbour	4a	56	13	1876
Newhaven One fixed *red* light	41 17.5 72 55.	On end of Long Wharf	6a	21	8	1861
STRATFORD SHOALS Rev. br. lt., 10 secs.	41 3.5 73 5.7	Granite lt.-ho. on Middle Ground	4b	65	13	1877 1878
Stratford River One rev. br. lt., 1½ m.	41 9.1 73 6.2	Tower, striped black and white, on W. entr. point of river	3b	53	12	1821
Bridgeport One fixed *red* light	41 9.4 73 10.5	White on red piles on the shoal, W. side of entrance to river. Shown all round	4a	60	10	1871
Penfield Reef One *red* flash. lt., 5 s.	41 7.1 73 12.8	A white tower on the reef, near S.W. entr. pt. of Black Rock and Bridgeport Harbours	4b	46	13	1874
Old Field Point One fixed bright lt.	40 58.6 73 6.8	White tower, 34 ft. high, on South side of Long Island Sound. Shown northward from W. by S. ¼ S. to E.	4a	77	13	1823 1869
Black Rock Harbour One fixed bright lt.	41 8.5 73 12.7	White tower, 35 ft. high, on Fairweather Id. Shown from E.N.E., by the South, to N.	5a	42	12	1808 1854
EATON'S NECK One fixed bright lt.	40 57.2 73 23.4	White tower, 60 ft. high, on E. side of entr. to Huntington Bay. Shown northward from W. to E.S.E.	3a	142	17	1798 1868

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
LONG ISLAND SOUND—*(continued).*						
Lloyd's Harbour One fixed bright lt.	40 54.9 73 25.7	White tower, 34 ft. high, on S.E. point of Lloyd's Neck, N. side of entrance	5a	40	10	1857
Norwalk Island One fixed & flash. lt.	41 2.9 73 24.9	White granite tower, 34 ft. high. Bright lt., with red flash every minute. At W. entr. of Norwalk River. Guide to N. shore of Long Island Sound, and to river. Shown southward from W. by S. ¼ S. to E. by N. ½ N. A rocky ledge half a mile to S.S.W.	4b	50	11	1826 1875
Great Captain Island One fixed bright lt.	40 58.9 73 37.1	White granite tower, 34 ft. high, near Greenwich Point. Shown from E. by N. to N.W.	4a	72	12	1829 1868
Execution Rocks One fixed bright lt.	40 52.6 73 43.9	White tower, 42 ft. high, on rock off Sands Pt.	4a	54	12	1848 1856
SANDS POINT One rev. br. lt., ½ m.	40 51.9 73 43.5	White tower, 41 ft. high, on East side of entr. to Cow Bay, Long Island. Shown northward from S.W. ½ S. to E.N.E.	4b	68	15	1809 1864
Stepping Stones One fixed *red* light	40 49.4 73 46.2	From dwelling on W. Stepping Stone Rock, E. River, entrance to Long Island Sound	5a	47	10	1877
Throgg's Neck One fixed bright lt.	40 48.3 73 47.1	White tower, 61 feet high, on S.E. point of Neck, at N.W. entrance to E. River. Shown southward from W. to N.N.E. ¾ E.	6a	66	10	1826 1875
North Brother One fixed bright lt.	40 48. 73 51.	On S. part of island, in the East River, between Long Island Sound and New York	6a	50	10	1869
Blackwell Island One fixed *red* light	40 46.2 73 56.1	Gray tower, 40 ft. high	4a	54	13	1872
NEW YORK AND NEW JERSEY.						
MONTAUK POINT One fix. and flash. br. lt.	41 4.2 71 51.1	White tower, 97 ft. high, at E. end of Long Id. A brighter flash every 2 minutes. Shown eastward from N.W. by W. ¼ W. to S.W.	1c	170	20	1795 1860
GREAT WEST, or SHINNECOCK BAY One fixed bright light	40 50.9 72 29.9	Red brick tower, 150 ft. high, on Pondquogue Point, N. side of Shinnecock Bay, 1½ mile inland from S. coast of Long Island. Shown southward from N.E. by E. to S.W. by W.	1a	160	20	1857
FIRE ISLAND One rev. br lt., 1 min.	40 37.9 73 12.8	Yellow tower, 150 feet high, on East side of inlet, S. side of Long Island. Shown southward from W. by S. to E.N.E.	1b	166	20	1826 1858
NEW YORK BAY						
SANDY HOOK LT.-V. Two fixed *red* lights	40 26.9 73 52.	Painted red, in 14 fms., 6½ miles from Sandy Hook and Navesink lights	●	45	10	1823 1862
"Scotland" Wreck Lt.-vessel	.....	Moored in 7 fms. at entr. to New York Bay, N.E. ¼ N. from Highlands of Navesink lts.	●	45	10	1874
HIGHLANDS OF NAVESINK Two fixed bright lts.	40 23.7 73 58.8	Brown stone towers, each 58 ft. high, South side of Sandy Hook, 76 yds. apart. Shown eastward, from N.W. to S. by E.	1a 1a	248 248	22 22	1828 1862
SANDY HOOK Three fixed bright lts.	40 27.6 73 59.8	S. entrance to New York Harbour. East lt. is on N. point of Sandy Hook, N. by W., ¾ of a mile, and West light N.W., ¼ of a mile, from main light	3a 4a 6a	90 43 45	15 9 10	1762 1868
Main Channel Two fixed bright lts.	40 25.2 74 4.	Lower lt. on Conover Beacon, South shore of Sandy Hook Bay. Upper light on Chapel Hill, 1½ mile to S. by W.	3a 2a	60 224	12	1856
Gedney's Channel Two fixed bright lts.	40 26.9 74 7.9	Leading lights near Point Comfort, ¾ of a mile apart, in one bearing W. by S.	2a 3a	40 76	12 14	1856
Swash Channel Two fixed bright lts.	40 33.7 74 6.9	Range lts. on Staten Island, near Elm Tree Station and New Dorp, 1½ mile apart; in line, bearing N.W.	2a 3a	189 59	20 12	1856
Great Beds One fixed *red* light	40 29.2 74 15.3	Raritan Bay. Red iron tower, 42 ft high, of five sections, standing on an iron pier filled with concrete. Lantern painted black	●	52	10	1880
Prince's Bay One fix. & flash. br. lt.	40 30.4 74 12.5	Brown tower, 33 ft. high, near S.E. end of Staten Island. Flash every 2 minutes. Guide to Amboy and Raritan River. Shown from E. by N. to S.W. ¾ W.	3c	106	16	1828 1857
Fort Tompkins One fixed bright lt.	40 36. 74 2.9	Drab tower, 46 ft. high, on Staten Island, W. side of Narrows. Shown eastward from N. ¾ W. to S.W. by S.	4a	89	15	1839 1873

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
NEW YORK BAY—*(continued)*.						
Robbins Reef One fixed bright lt.	40 39.4 74 3.6	White stone tower, 51 ft. high, off Tompkinsville, N.W. part of New York Harbour	4a	56	13	1839 1875
Hudson River Fixed lights	.....	Twenty or thirty lts. are shown from beacons, piers, &c., between New York and Albany...	..	..	..	....
NEWARK BAY						
Bergen Point One fixed bright lt.	40 38.5 74 8.6	On a reef, at entrance to Newark Bay	6a	48	10	1849 1875
Corner Stake One fixed *red* light	40 38.7 74 9.8	Opposite Elizabeth Port	6a	..	..	1857
Passaic River One fixed bright lt.	40 41.7 74 7.3	At mouth of river	6a	40	10	1849
Elbow Beacon One fixed bright lt.	40 42.1 74 7.1	On shoal point, ½ a mile N. of Passaic light	6a	27	6	1854
NEW JERSEY.						
BARNEGAT One flash. br. lt., 10 s.	39 45.8 74 6.1	Red and white tower, 150 ft. high, on N. end of Long Beach, S. side of inlet. Shown from N. by E. to S.S.W.	1b	165	20	1831 1858
TUCKER'S BEACH One fixed bright, & *red* flashing light, 2 min.	39 30.3 74 16.8	Gray tower, 44 ft. high, ¾ mile northward of entr. to Little Egg Harb. Shown from N.E. by N. to S.W. by S. Fixed br. for 1 min., followed by 6 consecutive red flashes, at intervals of 10 secs.	4c	50	12	1867 1879
ABSECOM One fixed bright light	39 22. 74 25.6	Tower, 159 ft. high, painted white with a red band, 50 ft. wide, round its middle portion; on S. side of inlet. Shown from N.E. by N. to S.W.	1a	167	20	1856
Hereford Inlet One fixed *red* light	39 0. 74 48.	Straw-coloured building surrounded by trees	4a	51	13	1874
CAPE MAY, or FIVE-FATHOM BANK LT.-V. Two fixed bright lts.	38 48.3 74 36.2	Painted straw colour. In 9 fms., E. 23 miles from Cape Henlopen lt., and S.E. of Five-Fathom Bank. Pass S. and E. of lt.-vessel...	● ..	45 40	10 ..	1839 1878
CAPE MAY One br. rev. lt., ½ min.	38 55.8 74 57.3	Gray tower, 155 ft. high, on N. side of entrance to Delaware Bay. Shown from N.E., by the S., to N.	1b	167	19	1823 1859
CAPE HENLOPEN One fixed bright light	38 46.6 75 4.7	White tower, 82 ft. high, on S. side of entr. to Delaware Bay. Shown from N.W. to S. by E.	1a	128	17	1792
Beacon Light One fixed bright light	.....	A white screw pile lt.-ho., 1 mile N.W. of main light. Shown from W. by S. to S. by E. ...	4a	45	11	1864
DELAWARE BAY AND RIVER						
Breakwater One fix. & flash. br. lt.	38 47.9 75 6.1	White tower, 45 ft. high. Flash every 45 secs.	4c	47	10	1849 1855
Brandywine Shoal One fixed bright lt.	38 59.1 75 6.5	Red iron screw pile tower	3a	46	13	1850 1857
Fourteen-foot Bank Lightvessel Two fixed bright lts.	39 3. 75 11.	Lt.-ves., painted yellow, in 6 fms., 3 cables E. of bank, 5 miles N.W. ¾ W. from Brandywine lt., and 6¾ miles S.S.E. ½ E. from Cross Ledge lt. Pass eastward of her	● ..	43 29	10 ..	1876
Maurice River One fixed bright lt.	39 11.6 75 1.8	White tower, 39 feet high, on S.W. side of Haystack Island. Shown from E.S.E. to N.W. ½ N.	6a	48	11	1849
Mispillion River One bright fixed lt.	38 56.7 75 18.5	Buff tower near the entrance	6a	48	11	1873
Egg Island One fixed bright lt.	39 10.5 75 8.1	White lighthouse on N. side of bay. Shown from N.W. ½ N. to N.E.	5a	45	11	1837 1878
Mahon River One fixed bright lt.	39 10.5 75 24.3	New tower, painted buff, 660 yds. N. by E. ¾ E. from position of old lt.	5a	53	13	1831 1875
Cross Ledge Shoal One flashing bright lt. every ¼ minute	39 9.5 75 14.5	Iron lt.-ho., ½ mile within S. extr. of shoal, W. by S. 4¾ miles from Egg Id. lt., and E. by S. 7¾ miles from Mahon lt.	4c	38	12	1875

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
DELAWARE BAY AND RIVER—(*continued*).						
Cohanzey One fixed bright lt.	39 20.3 75 21.3	Lt.-ho., 40 ft., on W. side of creek, E. side of bay. Shown to S. from N.W. ¼ W. to S.E. ¼ S.	5a	46	11	1838 1855
Ship John Shoal One fixed *red* light	39 18.3 75 22.7	Black lt.-house and brown dwelling.	●	53	13	1877
Bombay Hook	39 21.8	Bright lt. from tower, on N.W. end of island	4a	46	11	1831
Port Penn Two fixed bright lts.	39 29.5 75 35.7	From black tower, in trees, and white frame-work, 1½ m. apart. In line lead up channel fr m S.E.-ward	.. ..	133 33	.. ..	1877 ....
Reedy Island One rev. br. lt., ½ m.	39 30. 75 34.	Drab-coloured lt.-ho., lantern black, on S. pt. Thirty feet of the old tower remains standing	5b	30	..	1839 1879
Finn Point Two fixed bright lts.	39 35.6 75 32.7	From black tower, in trees, and white frame-work, 1½ m. apart. In line lead up channel from southward	.. ..	98 23	.. ..	1877 ....
Newcastle	39 38.	Two fix. br. leading lts., ½ mile apart. To mark channel passing Pea Patch Island	..	..	..	1876
Deep Water Point	39 41.	Two fix. br. leading lts., 1¼ mile apart. To mark channel at upper part of Bulkhead Shoal	..	..	..	1876
Christiana River	39 43.3	Bright fix. lt. at Wilmington, N. side of river	4a	48	11	1835
Cherry Island Flats Two fixed bright lts.	39 45. 75 29.8	Lights ¾ mile apart; in line, lead through dredged channel across the flats	● ●	28 113	.. ..	1880
Fort Mifflin	39 52.1	Bright light on pier, opposite the fort	6a	28	7	1849
Schuylkill River	39 53.3	Two fix. br. lts. In line, lead through dredged channel into Schuylkill River	..	..	..	1876
FENWICK ISLAND One fixed and flash. lt.	38 27. 75 4.1	White brick tower, 82 ft.; fixed lt., with flash ev. 2 min. Shown eastward from N. to S.	3d	86	15	1858
VIRGINIA.						
Winter Quarter Shl. Lt.-V. One fixed bright light	37 57. 75 5.5	Painted red, in 11 fathoms, S.E. by E. ½ E., 2 miles from centre of shoal	..	15	11	1874
ASSATEAGUE ISLAND One bright fixed light	37 54.6 75 21 1	Red brick tower, 129 ft. high, 2 miles from S.W. pt. of Id. Shown eastward from N.N.E. ¾ E. to W.S.W. Very dangerous shoals lie from 5 to 11½ miles to N.E., E., and S.E.	1a	150	19	1833 1867
Hog Island One fixed bright light	37 23.3 75 41.6	White tower, 45 ft. high, W. pt. of Id. Guide to Great Matchipongs Inlet. Shown eastward from N. by W. ½ W. to W. by S. ½ S.	4a	60	13	1852 1855
CHESAPEAKE BAY						
CAPE CHARLES One fixed & flash. lt.	37 7.1 75 53.2	New circular white tower, 150 ft. high, near N.E. end of Smith Island, North side of entrance to Chesapeake Bay. Flash every 45 secs. Shown all round	1c	150	21	1864
CAPE HENRY One fixed bright lt.	36 55.5 76 0.2	White tower, 82 ft. high, near sand-hills on S. side of entrance	2a	129	17	1791 1857
The Thimbles One br. fix. lt., *red* fl.	37 0. 76 14.	Screw pile lt.-ho. on the Horseshoe Bank, in 11 ft. Pass to southward. Red flash ev. 15 secs. (Lt.-ho. burnt, 1880; temporary lt. shown)	4c	44	12	1872
Old Point Comfort One fixed bright lt.	37 0. 76 18.4	White tower, 40 ft. high, on N. side of entr. to Hampton Roads and James River. Shown from N. ½ W., eastward, to W. ½ S.	4a	48	11	1802
Craney Island Shoal One fixed bright lt.	36 53.5 76 20.3	Piles on W. side of entr. to Elizabeth River. Fog-bell ev. 12 secs. Shown eastward from W. by N. ¼ N. to S. by W. ½ W.	5a	40	11	1820 1854
Lambert Point One fixed *red* light	36 52.2 76 20.	Screw pile lt.-ho. off Lambert Point, in 6 ft. water, E. side of channel to Elizabeth River	5a	36	10	1872
Portsmouth One fixed *red* light	36 50.8 76 18.1	On wharf of Naval Hospital, from mast 45 ft. high, 60 ft. N. of former light-station	6a	..	6	1857 1878
Nausemond River One fixed *red* light	36 54.8 76 26.5	Pile lt.-ho. white with red roof, in 5½ ft. water, at river entr.	6a	33	11	1878
James River One fixed bright lt.	37 1.4 76 31.5	(White Shoal.) Screw pile lt.-ho. below Sandy Point.	6a	27	9	1854
Point of Shoals One fixed bright lt.	37 3.8 76 39.2	White screw pile lighthouse on the shoal.	6a	27	9	1854
Deep Water Shoals One fixed bright lt.	37 8.2 76 38.	White screw pile lighthouse on the shoal.	6a	27	9	1854
Jordan's Point One fixed bright lt.	37 18.7 77 13.1	White tower, 35 ft. high, on the port side going up James River.	6a	35	10	1854

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CHESAPEAKE BAY—(*continued*).						
Cherrystone Inlet One fixed bright lt.	37 15.6 76 1.8	White pile lighthouse on W. side of entrance of inlet, E. side of Chesapeake Bay.	4a	36	10	1859
Back River Fix. & fl. br. lt., 1½ m.	37 5.2 76 15.9	White tower, 30 ft. high, on South side of entrance	4b	35	10	1829 1854
York River 1. One fixed *red* lt. 2. One fix. bright lt.	37 12.3 76 14.7	1. Screw pile lt.-ho., painted yellow, in 12 ft. water, at E. end of York Spit. 2. Brown, white, and red pile lt.-ho. at Toos Point	● ••	37 40	11 11	1870 1875
New Point Comfort One fixed bright lt.	37 18. 76 16.4	Stone tower, 56 ft. high, on N. side of entrance to Mobjack Bay	4a	60	13	1804 1855
Wolf Trap Shoals One bright light, with flash every ½ min.	37 23.3 76 10.	Screw pile lighthouse on East side of shoal, between York and Rappahannock Rivers.	4a	36	11	1870
Stingray Point One fixed *red* light	37 33.6 76 15.9	White pile lt.-ho., in 6 ft. water, on S. side of Rappahannock River.	6a	36	7	1859
Windmill Point One fixed bright lt.	37 34.8 76 14.5	Pile lighthouse, straw colour, in 12 ft. water, on S.E. part of shoal, N. side of Rappahannock River.	●	34	10	1834 1854
Watts Island One fixed & flash. lt.	37 46.9 75 53.8	White tower, 40 ft. high, on South end, East entrance to Tangier Sound. Flash every 2 minutes	5c	46	12	1833 1857
MARYLAND.						
Janes Island One fixed bright light	37 57.8 75 55.	White lt.-ho., brown roof and piles, off mouth of Annamessix River, Tangier Sound, 300 ft. W. of old lighthouse.	4a	38	11	1867 1879
Somers Cove One fixed bright lt.	37 58. 75 52.2	In Tangier Sound.	6a	35	10	1867
Smith Point One fixed & flash. lt.	37 53.6 76 11.4	White pile lighthouse, on S. side of entrance of Potomac. Bright lt., with red flash every 25 secs.	3c	38	11	1869
Solomon Lump One fixed light	38 2.8 76 0.5	White lt.ho. on piles in 6 ft., opposite entr. of Potomac River. Lt. vis. from N.N.W. by the W. to E.N.E.	5a	42	11	1875
Clay Island One fixed bright lt.	38 13.9 75 58.1	N. side of entrance to Nanticoke River	6a	36	10	1832 1855
Lookout Point One fixed bright lt.	38 2.3 76 19.	N. side of entrance to Potomac River.	4a	37	10	1831 1857
Hooper's Strait One fixed bright lt.	38 13.5 76 4.2	Screw pile lt.-ho., upper part white, lower brown, N. side of strait, betw. mainland and Bloodsworth Id.	5a	40	11	1867 1879
Cove Point One fixed & flash. lt.	38 23.1 76 23.6	White tower, 39 ft. high, 4 miles North of Patuxent River, on W. side of Chesapeake. Flash every 1½ minute.	4d	46	11	1828 1857
Sharp Island One bright fixed lt.	38 37.9 76 22.3	On a screw pile lighthouse, in 7½ ft. water, off N.W. point of island. Lt. shown westward between S. by W. and E. by S.	5a	35	10	1866
Choptank River One bright fixed lt.	38 39.3 76 11.	Screw pile white lt.-ho., in 9 ft. water, 1¼ mile S.E. of Benoni Point.	6a	38	10	1871

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CHESAPEAKE BAY—(*continued*).						
Thomas Point Shoal One rev. *red* lt. 30 s.	38 54.2 76 25.7	White & brown pile lt.-ho. I mile E. by S. ¾ S. from position of old lt.	●	42	12	1875
Greenbury Point One fixed bright lt.	38 58.3 76 26.9	N. side of Annapolis Harbour, at entrance to Severn River	6a	50	11	1848 1855
Sandy Point One fixed & flash. lt.	39 1.1 76 23.5	Wh. tower, 35 ft. high, on W. side of Chesapeake. Flash every 1½ min.	5d	50	12	1858
Love Point One fixed bright lt.	39 4. 76 16.5	A screw pile lighthouse, in 10 ft. water, at 1¼ mile N.E. from Love Point, entrance of Chester River.	4b	37	10	1872
PATAPSCO RIVER						
Leading Lights for Craighill Channel Two bright fix. lts.	39 11.2 76 23.3	Inner lt. at S. end of Hart Id.; shown only down channel. Outer lt.. iron lt.-ho., black, in 14 ft. water, near mouth of Patapsco Riv., 2½ miles from inner lt. It also shows a lower fixed lt. at 17 ft., down the channel. The lts. in line N. ¼ E. lead in.	2a 5a	106 30	16 11	1874 1874
Seven-Foot Knoll One fix. *red* lt.	39 9.3 76 24.2	Black screw piles, S. side of entr. to Patapsco River.	4a	43	11	1855
Fort Carroll One fix. bright lt.	39 12.8 76 30.8	On the fort.	5a	37	10	1854
Hawkins Point One bright fixed lt.	39 12.3 76 31.5	On iron piles. On shoal, on S. side of Patapsco River	2a	70	10	1868 1879
Leading Point One bright fixed lt.	39 12.7 76 32.9	Brown tower, 40 ft. high, on N. side of Baltimore Harbour. In line with Hawkins Point lights, 1⅛ mile to W. by N. ¾ N., lead up the channel	2a	70	14	1868
Lazaretto Point One fixed *red* light	39 15.7 76 34.	N. side of Baltimore Harbour.	4a	35	10	1831 1855
Pool Island One fixed bright lt.	39 17.4 76 15.7	White tower, 30 ft. high, off mouth of Gunpowder River.	4a	35	10	1825 1855
Susquehanna River						
Turkey Point One fixed bright lt.	39 26.9 76 0.2	White tower, 30 ft. high, on bluff point, N. side of entrance to Elk and Susquehanna Rivers	4a	65	12	1833 1855
Fishing Battery One fixed bright lt.	39 29.6 76 4.7	On Fishing or Donoho's Battery	6a	36	10	1853
Havre de Grace One fixed *red* lt.	39 32.4 76 4.8	Concord Point, entrance of Susquehanna River	6a	40	10	1825 1879
POTOMAC RIVER						
Piney Point One fixed bright lt.	38 8.1 76 31.5	E. side, about 14 miles N.W. of mouth	5a	35	10	1836 1856
Blakistone Island One fixed bright lt.	38 12.4 76 44.4	White tower, 41 ft. high, near entrance of Clement Bay	4a	46	11	1851 1856
Lower Cedar Point One fixed bright lt.	38 20.3 76 59.3	Screw pile lighthouse, in 3 ft. water, between Cedar and Yates Points.	●	35	10	1825
Mathias Point One fix. bright lt.	38 24.1 77 2.3	Screw piles red, lantern white, on shoal off pt.	5	43	12	1876

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CHESAPEAKE BAY—(*continued*).						
POTOMAC RIVER—(*continued*).						
Fort Washington One fixed bright lt.	38 42.7 77 1.9	On the wharf	6a	..	6	1857
Jones Point One fixed bright lt.	38 47.4 77 2.1	Near Alexandria	5a	35	10	1855
Bowler Rock One fixed bright light	37 49.2 76 43.5	Pile lighthouse, on S. side of Rappahannock River, 26 miles above entrance.	5a	35	10	1835 1868
NORTH CAROLINA.						
CURRITUCK BEACH One fix. & flashing lt.	36 21.8 75 49.3	Fixed bright lt., and red flash every 1½ min. Red brick tower, 150 ft. high	1c	157	18	1876
BODIES ISLAND One fixed bright light	35 49.3 75 33.4	Brick tower, rebuilt, black and white bands, 1½ mile N. of Oregon Inlet	1a	156	18	1872
CAPE HATTERAS One flash. br. lt., 10 s.	35 15.1 75 31.	Tower, 180 ft. high, black & white spiral bands, about 2 miles N. of cape. Dangerous shoals 9 or 10 miles to S.E.	1b	185	22	1798
PAMPLICO SOUND						
Oliver Reef One *red* flash. lt. 30 s.	.....	Pile lt.-ho., in 7 ft. water, on reef, Hatteras Inlet, Pamplico Sound.	4b	36	11	1874
Ocracoke Island One fixed bright lt.	35 6.5 75 58.9	White tower, 65 ft. high, on W. end of island, N. side of entrance to the inlet	4a	75	15	1823 1854
Royal Shoal, S.W. Pt. One fixed bright lt.	35 7. 76 7.	White screw piles, in 7 ft. water, on S.W. point. (Discontinued, 1880)	4a	38	10	1826 1867
Royal Shoal, N.W. Pt. One fixed & flash. lt.	35 9.2 76 9.2	White screw piles, in 6 ft. water, on N.W. point. Flash every 1½ min.	4d	33	10	1857
Harbour Island One bright fixed lt.	35 0.5 76 13.	White screw piles on bar, betw. Pamplico and Core Sounds. (Discontinued, 1880)	5a	34	10	1836
Brant Island Shoal One fixed bright lt.	35 8.1 76 17.3	Pile lt.-ho. in 7 ft., on S.E. pt. of shoal, in S. pt. of Pamplico Sound.	5a	..	..	1851 1877
Neuse River One bright fixed lt.	35 5.3 76 32.6	Pile lighthouse, in 5 ft. water, off Marsh Point, W. side of entrance to Neuse River.	5a	38	11	1828
Pamplico Point One fixed bright lt.	35 19.4 76 31.3	White tower, 34 ft. high, on S. side of entrance to Pamplico River	5a	37	11	1828 1856
Long Shoal One bright fixed lt.	35 34. 75 42.	White pile lighthouse, on E. point of shoal, in 9 ft. water.	4a	35	10	1854 1867
Roanoke Marshes One fixed *red* light	35 48.5 75 41.8	White pile lighthouse, in 9 ft. water, on E. side of channel, between Pamplico and Croatan Sounds.	4a	33	11	1874 1877
Croatan One fixed bright lt.	35 57.6 75 47.4	White screw piles, between Croatan and Albemarle Sounds.	4a	35	10	1835 1866
Laurel Point One br. rev. lt., ½ m.	35 59.8 76 23.9	S. shore of Albemarle Sound. Hexagonal pile lt.-ho., in 9 ft. water, due N. from the point; piles brown, lt.-ho. white, lantern red	4b	40	12	1880
Wade's Point One fixed bright lt.	36 9.1 75 58.3	White pile lighthouse, on end of shoal, West side of Pasquotank River, Albemarle Sound.	5a	31	10	1854 1866
North River One fixed *red* light	36 9.3 75 53.5	On screw piles, in 3½ ft. water, on bar of Albemarle Sound.	5a	35	10	1866
Roanoke River One fixed bright lt.	35 56.8 76 41.4	White screw piles, in 7½ feet water, near entrance.	4a	35	10	1835 1877

Name and Character of Light.	Lat. N. Long. W. o '	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
CAPE LOOKOUT One fixed bright light	34 37.3 76 31.1	Tower, 150 ft. high, chequered black and white, near end of cape. The old tower is painted in red and white horizontal bands. Lt. shown to eastward from N.N.E. to W.N.W. Dangerous shoals extend 11 miles to S.S.E. from the lt.	1a	156	22	1812 1859
Fryingpan Shoals Lt.-V. Two fixed bright lts.	33 35. 77 50.	Painted yellow; schooner-rigged. In 10 fms., 1 mile from outer shoal.	●	40	12	1854
CAPE FEAR RIVER						
CAPE FEAR One fixed bright lt. One beacon light	33 52.3 77 59.8	Re-exhibited from old white pyramidal tower on Bald Head, E. side of entr. to Cape Fear River. Small beacon lt. S.W. by W. ½ W. ½ mile from main lt. In line, indicate dredged Channel	4a ..	100 ..	16 4	1880 ....
Oak Island Two fixed *red* lts.	33 53.4 78 1.6	On E. end of island, 3 miles below Wilmington. In one, N. ¾ E., 267 yds. apart, lead over the bar	6a 4a	33 45	9 ..	1849 1866
SOUTH CAROLINA.						
Georgetown One fixed bright light	33 13.4 79 10.9	White tower, 82 ft. high, at East side of entrance to Pedee River	4a	85	15	1801 1867
CAPE ROMAIN One rev. br. lt., 1 min.	33 1.1 79 22.2	On Raccoon Kay. New red brick tower, 150 ft. high. Old tower, 65 ft. high, and white-washed, stands near. Shoals extend 6 miles beyond the cape	1b	154	20	1827 1860
Bull's Bay One fixed bright light	32 55.3 79 33.7	Red brick house on N. end of island	4a	35	11	1852
Rattlesnake Shoals Lt.-V. Two fixed bright lights	32 44.1 79 43.6	White hull; two masts; in 5½ fathoms, with Fort Sumter W. ¾ N., and red beacon on Morris Island W. by S. ½ S. Fog-horn and bell	●	44	12	1854
CHARLESTON HARBOUR						
Morris Island 1. One fixed br. lt. 2. Two *red* fixed lts.	32 41.9 79 52.5	1. Tower, 150 ft. high, painted in black and white bands; near South end of Morris Id. Cata-dioptric light 2. Two beacons on S. end of island; E. tower, red; West, black. Two lts. in one, 360 yds. apart, bearing W. by N. ½ N., lead over the bar into the main ship channel, which is shifting to the southward	1 5a 5a	152 20 40	18 7 9	1876 1870
Sullivans Island Two fixed red lights	32 47. 79 51.	One on N.E. bastion of Fort Moultrie; the other by the cove, 300 yds. to northward. In one, lead through main ship channel	5a 5a	57 34	10 10	1848 1872
Fort Sumter One fixed bright light	32 45.1 79 52.3	On the fort, on West side of entrance	5a	57	10	1855 1866
Fort Ripley Shoal One fixed *red* light	32 45.8 79 54.	Pile lt.-ho., painted yellow, in 8 ft. water	..	43	12	1878

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
ST. HELENA SOUND One rev. br. lt., ½ min.	32 23. 80 25.	Lt.-ho. white to top of foliage, black above, on Hunting Id., S. side of entr. to Sound ...	2b	132	17	1875
Martin's Industry Lt.-V. Two fixed bright lights.	32 5.5 80 35.2	Painted red, schooner-rigged, at 15 miles eastward of Tybee light.	●	44	12	1839 1855
GEORGIA.						
SAVANNAH RIVER						
Daufuskie Island Two fixed bright lts.	.....	High lt. N. ½ W., 750 yds. from low lt. Leading lts. for channel, from Tybee Roads into Calibogue Sound.....	5a 5a	61 18	.. ..	1873 ....
TYBEE ISLAND Two fixed bright lts.	32 1.3 80 50.5	Main light, a white tower, 134 ft. high, on N.E. end of the island, S. side of entrance to Savannah River; beacon light on a white tower, 50 ft. high, on N.E. extreme of island, ¾ of a mile E. of main light	1a 4a	150 65	20 12	1793 1822
Cockspur Island One fixed bright lt.	32 1.4 80 52.6	On a knoll, off E. end of the island	6a	25	9	1849 1856
Tybee Knoll Beacons Two bright fix. leading lights	32 2. 80 54.3	At E. end of Long Island. Beacons painted white. In line, W. ¾ S. 717 yds. apart, lead through dredged channel from Tybee Road into Savannah River.....	6a 6a	44 21	.. ..	1878 1878
Oyster Beds One fixed *red* light	32 2.3 80 53.5	Opposite Cockspur Island, to mark South channel. Fog-bell.....	6a	35	9	1849 1856
Fig Island One fixed *red* light	32 4.8 81 3.9	Pile lt.-ho. in 5 ft. water, S. side of island; leading lt. for Wrecks Channel	6a	23	..	1848 1880
Savannah One fixed *red* light	32 4.8 81 5.4	Shown from tower of the Exchange Building in the city. In line with Fig Island light, leads through Wrecks Channel	..	123	..	1880
SAPELO ISLAND 1. One fixed & flash. lt. 2. One fixed bright lt.	31 23.5 81 16.9	1. Tower, 70 ft. high, red and white horizontal bands, S. end of island, N. side of Doboy Sound. Flash every 45 seconds ..... 2. Fixed light in front or seaward of former...	4c 6a	79 50	14 11	1820 1854 1858
Wolf Island Two fixed bright lts.	31 21.1 81 16.5	White towers, 38 and 30 ft. high, near N. end of island, S. side of Doboy Sound	6a ..	38 30	10 10	1822 1856
ST. SIMON'S ISLAND One fix. and flashing lt.	31 8. 81 23.4	White tower, 100 ft. high, on N. side of Sound. Bright fixed light, with alternate red and bright flashes every minute	..	..	..	1811 1872
LITTLE CUMBERLAND ISLAND One fixed bright light	30 58.6 81 24.6	White tower, 61 ft. high, on S. side of entrance to St. Andrew Sound and Santilla River ...	3a	78	14	1838 1856

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
FLORIDA.						
AMELIA ISLAND Fix. & fl. br. lt., 1½ m.	30 40.4 81 26.3	White tower, 58 ft. high, 2 miles from N. end of island	3c	112	16	1839
N. Range Beacons Two fixed *red* lights	30 42. 81 26.3	Two pyramidal frame towers, on N. end of Amelia Id. Lts. in line, lead over the bar at entrance of Fernandina Harbour	●	..	..	1872 1880
ST. JOHN'S RIVER 1. One fixed bright lt. 2. One fixed bright lt.	30 23.7 81 24 7	1. Red tower, 74 feet high, on South side of entrance to Jacksonville 2. Screw pile lightho., in 6 ft. water, off Dames Point; pass on either side	3a 5a	84 36	14 10	1829 1859 1872
ST. AUGUSTINE One fixed lt., with flash every 3 minutes	29 53. 81 17.	A new lighthouse near old one, painted in black and white spiral bands, 150 ft. high, on N. end of Anastasia Id., S. side of entr.	1c	160	19	1874
CAPE CANAVERAL One br. rev. lt., 1 min.	28 27. 80 33.	New iron tower, 55 ft. high, black and white belts, on N.E. pitch of cape. Dangerous shoals lie from 6 to 11½ miles to north-eastward from the cape	1b	139	18	1847 1868
JUPITER INLET One fix. & flash. br. lt.	26 55.4 80 5.1	Red brick tower, 94 ft. high, between the inlet and Gilbert Bar. Fixed lt., with flash every 1½ min.	1c	146	18	1860
CAPE FLORIDA (Fowey Rocks) One fixed bright light	25 35.3 80 5.8	Iron lt.-ho., painted brown, in 5 ft. water, 50 yds. S. of beacon P. Keeper's dwelling white. Catadioptric (reflector and lens) of the first order	..	110	16	1878
CARYSFORT REEF One rev. br. lt., ½ min.	25 13.3 80 12.7	Iron piles, 112 ft. high, dark brown colour, on the reef	1b	106	18	1852 1857
ALLIGATOR REEF One flashing lt., 5 secs.	24 51. 80 37.	White iron framework and dwelling, in 5 ft. water, near N.E. point of reef. Two bright flashes, then one red	1b	143	18	1873
SOMBRERO SHOAL One fixed bright light	24 37.6 81 6.7	Edge of the shoal, pile lt.ho., dark colour, 149 feet high, near Coffin Patches and Sombrero Key	1a	144	18	1857
AMERICAN SHOAL One br. flash. lt. 5 secs.	24 31.4 81 31.3	Brown iron frame-work lt.-ho., stairway cylinder white, in form of a truncated pyramid, on piles, in 6 ft. water, 200 ft. N.W. of Beacon B, Florida Reefs	1b	109	16	1880
SAND KEY One fixed and flash. lt.	24 27.2 81 52.7	Dark tower, 121 ft. high, on a small islet, 7¼ miles S.W. of Key West light. Fixed lt., with flash every 2 minutes	1c	110	18	1826 1853
KEY WEST						
S.W. Point of Island One fixed bright lt.	24 33. 81 48.1	White tower, 55 ft. high, ½ a mile inland	3a	70	13	1825 1858
N.W. Passage One fixed bright lt.	24 37.1 81 54.1	On iron screw piles, in 6 ft., on N.E. point of reef, 6½ miles N.W. by W. from Key West	4a	40	12	1838 1854
DRY TORTUGAS						
LOGGERHEAD KEY One fixed bright lt.	24 38.2 82 55.7	Round tower, 150 ft. high, upper part black, lower white, on centre of W. Key	1a	152	20	1858
Garden or Bush Key One fixed bright lt.	24 37.8 82 52.9	Brown tower, 65 ft. high, on Fort Jefferson	4a	70	14	1826 1858

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
EGMONT KEY One fixed bright light	27 36. 82 46.2	White tower, 81 ft. high, on the Key, at entrance of Tampa Bay	4a	86	15	1848 1857
CEDAR KEYS One fixed and flash. lt.	29 5.8 83 4.8	White tower, 43 ft. high, on S.E. point of Seahorse Key. Flash every minute. A reef extends 12 miles to S.W.	4d	75	15	1854
ST. MARK'S HARBOUR One fixed bright light	30 4.4 84 10.6	White tower on East side of entrance	4a	73	14	1829 1856
DOG ISLAND	29 46 8 84 38.6	White tower, 44 ft. high, on East side of middle entrance of St. George's Sound ..... Destroyed by hurricane in 1873	4b	48	13	1838 1856
CAPE ST. GEORGE One fixed bright light	29 35.2 85 2.7	White tower, 70 ft. high, on the cape	3a	77	15	1847 1857
CAPE ST. BLAS One rev. br. lt., 1½ min.	29 39.8 85 21.6	White tower, 96 ft. high, 2 miles from South point of cape. Dangerous shoals extend 6 miles to S.S.W.	3b	96	16	1847 1858
PENSACOLA 1. One rev. br. lt., 1 m. 2. One bright fixed lt.	30 20.8 87 18.4	1. Black and white tower, 160 ft. high, near Barraneas, S. side of Pensacola Bar 2. Bar beacon, white, 150 yds. to S.S.E. ¼ E. from main lt. In one, N.N.W. ¼ W., lead over the bar	1b ..	210 ..	21 4	1824 1869 1859

ALABAMA.

MOBILE BAY

SAND ISLAND One bright fixed lt.	30 11.3 88 1.9	New brick tower, painted black, 140 ft. high, on a low island, 3 miles S.S.W. of Mobile Point	2a	132	17	1864 1873
Mobile Point One fixed *red* light	30 13.7 88 1.5	New tower, 37 feet high, painted black, on S.W. bastion of Fort Morgan, E. side of bay	4a	50	10	1864 1873
Choctaw Point One fixed bright lt.	30 40.2 88 1.1	Screw pile lighthouse, in 7 ft. water, ⅝ of a mile E. of the point.	4a	46	12	1872

MISSISSIPPI AND LOUISIANA.

MISSISSIPPI SOUND

Horn Island Bright fixed lt., *red* flash every min.	30 13.5 88 30.0	Pile lighthouse on E. end of island, Mississippi Sound.	4c	42	12	1874
Round Island One fixed bright lt.	30 17.5 88 34.2	White tower, 45 ft. high, on island off Pascagoula Bay. Hidden by woods to northward between N.W. by N. ¼ N. & N.E. by E. ¾ E.	4a	51	12	1833 1856
East Pascagoula River One fixed bright lt.	30 21.1 88 33.1	At East Pascagoula	5a	35	10	1854
Ship Island One fixed *red* lt.	30 12.9 88 57.	White tower, 48 ft. high, on W. end of island	4a	51	13	1853
Biloxi One fixed bright lt.	30 23.7 88 53.2	White iron tower, 48 ft. high, at W. entrance to bay	4a	62	13	1848 1856

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
MISSISSIPPI SOUND—(*continued*).						
Cat Island One fixed & flash. lt.	30 14.0 89 8.7	Screw pile lighthouse, on W. end of island. Flash every 1½ minute	5a	45	11	1871
Pass Christian One fixed bright lt.	30 18.7 89 14.	White tower, 30 ft. high, on mainland, 6½ miles N.W. of Cat Island light	4a	42	12	1831 1857
Merrill Shell Bank One fixed bright lt.	30 14.3 89 14.5	A pile lighthouse, between Cat Island and Grand Island.	4a	45	11	1860
St. Joseph's Island One bright fixed lt.	30 11.1 89 24.6	White, on brick pier, 34 ft. high, at entrance to Lake Borgne	5a	35	9	1865
Proctorsville One fixed bright light	29 52.4 89 39.5	Near fort at Proctorsville, Lake Borgne	6a	39	10	1850 1858
LAKE PONTCHARTRAIN						
West Rigolets One fixed bright lt.	30 10.6 89 43.6	At East entrance of Lake Pontchartrain	5a	30	10	1855
Herbes Point One fixed *red* light	30 9.5 89 51.5	Near extr. of point, on keepers' dwelling. Lt. shown northwd. betw. S.W. ½ W. & S.E. ½ E.	5a	40	11	1875
Port Pontchartrain One fixed & flash. lt.	30 1.8 90 2.7	White house near E. end of railroad. Flash every 1½ minute	5c	35	10	1838 1855
Bayou St. John One bright fixed lt.	30 1.9 90 4.	Screw pile lighthouse, 5 miles North of New Orleans	6a	39	10	1811 1855
New Canal One bright fixed lt.	30 1.7 90 5.8	At the entrance of the canal	5a	33	10	1838
Tchefuncti River One bright fixed lt.	30 23. 90 6.	Near Madisonville	5a	38	10	1837
Manchac Pass One bright fixed lt.	30 17.8 90 12.7	On S. side of Pass, between Lakes Maurepas and Pontchartrain	5a	45	12	1838 1857
CHANDELEUR ISLAND One fixed bright light	30 3.1 88 51.6	White tower, 50 ft. high, on N. end. Good anchorage inside the point, with the light bearing N.E. about 2 miles	4a	50	13	1848 1855
MOUTHS OF MISSISSIPPI						
PASS A L'OUTRE One fixed & flashing bright light	29 11.5 89 1.5	Black tower, 69 ft. high, on Middle Ground Island, N. side of entrance. Flash every 45 seconds.	3c	77	15	1855 1858
SOUTH PASS One rev. br. lt., 1½ m.	29 1. 89 10.	Wood tower, slate coloured, 54 ft. high, on Gordon Id., S.W. side of Pass. Whistle-buoy in 10 fms., S.E. of lt.-ho. Red lts. on E. side of Jetties	3b	60	13	1831 1858
Deer Island One fixed *red* lt.	29 8.6 89 15.1	At junction of S.W. & N.E. Passes.	5a	..	5	1852
SOUTH-WEST PASS One fixed bright lt.	28 58.5 89 23.5	New black tower, ½ mile S. by W. ¼ W. from former lt.-tower, on W. side of entr. of river.	1a	128	17	1831 1873

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Barrataria Bay One fixed bright light	29 16.2 89 55.	White tower, 55 ft. high, on West end of Grande Terre Island	4a	60	13	1864
TIMBALLIER ISLAND Bright fix. lt., with red flash every minute	29 1. 90 18.	Screw pile lighthouse, in 7 ft. water, painted black	2c	110	16	1875
SHIP ISLAND SHOAL One fixed and flash. lt.	28 55. 91 4.	Black iron pile lighthouse, 125 ft. high, off Raccoon Point. Fixed lt., with flash every ½ min.	2d	110	17	1860
SOUTH-WEST REEF One fixed light	29 25. 91 30.	Iron piles, black, on reef, at entr. of Atchafalaya Bay.	4a	49	12	1859
Calcasieu River One fixed bright light	29 46. 93 17.5	White pile lt.-ho. on E. pt. of entr. to river	4	55	13	1876
SABINE PASS One fixed and flash. lt.	29 43.9 93 50.3	White tower, 75 ft. high, on Brant Point, E. side of river. Flash every 1½ minute	3d	85	16	1856
TEXAS.						
GALVESTON BAY						
Lightvessel One bright fixed lt.	.....	Painted straw colour. In 4½ fathoms inside the bar.	..	47	11	1849 1870
BOLIVAR POINT One fixed bright lt.	29 22. 94 45.5	New iron tower, black and white horizontal bands, ½ a mile W.S.W. from former lighthouse. North side of entrance to Galveston	3a	117	17	1872
Half-moon Shoal One fixed bright lt.	29 24. 94 50.6	Iron piles, white and red corners; between Pelican Island and Dollar Point.	6a	34	6	1854
Red Fish Bar One fixed bright lt.	29 30.8 94 51.7	Building white and bl. lanthorn To mark channel across Red Fish Bar.	6a	35	10	1854
Cloppers Bar One bright fixed lt.	29 41.2 94 56.5	White building, to mark the channel. (Discontinued, 1880)	6a	35	10	1854
MATAGORDA BAY						
Matagorda Island One rev. br. lt., 1½ m.	28 21. 96 25.9	White wooden tower, on E. point of island, at entrance to Matagorda Bay	5b	35	10	1852
West Shoal One fixed bright lt.	28 25. 96 22.	White screw pile lighthouse, inside Decrows Point. On port side going in through the Swash Channel.	4a	35	11	1872
East Shoal One fixed *red* light	28 25.5 96 22.	White screw pile lighthouse. On starboard side going in through the Swash Channel	4a	35	11	1872
Half Moon Reef One fixed red light	28 33. 96 15.5	Pile lighthouse, on S. extremity of reef.	6a	35	11	1858
Swash	28 26.5 96 22.5	Screw pile lighthouse opposite Alligator Head.	5a	38	6	1858
ARANSAS PASS One fixed bright light	27 52.4 97 3.	Brown tower, 55 ft. high, on Low Island, inside the Pass. Seen outside when bearing N.W. ½ W.	4a	60	13	1855
BRAZOS SANTIAGO						
Padre Island One fixed bright lt.	26 4.7 97 8.7	Hexagonal lt.-ho., on screw piles; dwelling slate colour, the rest black	4a	58	13	1852 1879
ISABEL POINT One fixed & flash. lt.	26 4.9 97 11.1	White tower, 57 ft. high, on the point. Flash every minute	3d	82	16	1852 1886

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
WEST INDIES.						
BAHAMA ISLANDS (BRITISH).						
ABACO One rev. br. lt., 1 min.	25 51·3 77 11.2	White and red tower, 85 ft. high, on S.E. point, or Hole-in-the-Wall	●	160	16	1848
Little Guana, or Elbow Cay One fixed bright lt.	26 30.5 76 58.2	Circular stone tower, 77 ft. high, ¾ of a mile inland	1a	100	18	1863
GREAT STIRRUP CAY One fixed bright light	25 49.7 77 53·9	Stone tower, 46 ft. high, white, with two red bands. Shown northward from S.E. by E. to S.W.	3a	81	14	1863
NASSAU HARBOUR 1. One fixed bright lt. 2. One fixed bright lt.	25 5.6 77 22.4	1. Stone tower, 58 ft. high, on W. pt. of Hog Id. Lt. vis. from S.S.W., through N., to S.E. by S. ½ S. A red lt. is shown from a flagstaff near the lighthouse when Nassau Bar is impassable 2. On Athol Id., E. of Hog Id., from cupola of Quarantine Office. Lt. vis. betw. E. by S. ½ S. and S.S.E. ½ E.	●	68	10	1816 1847
GREAT ISAAC One rev. br. lt., ½ min.	26 2. 79 6.5	Tower, 145 ft. high, with red and white bands, on island, at N.W. end of Great Bahama Bank	●	158	16	1859
GUN CAY One rev. *red* lt., 1½ min.	25 34.6 79 18.8	Tower, 70 ft. high, upper part red, lower white, near S. point. Hidden by Bemini Islands, 8 miles to N., or from N. by E. ¼ E. to N. ¾ W.	..	80	12	1836 1873
CAY SAL BANK One fixed bright light	23 56. 80 28.5	Tower, 58 feet high, lower part red, upper white, on North elbow, or Pianquata Cay. Hidden by Water Cay, 9 miles to N.E. ¼ E.	..	96	15	1839
Anguila *Proposed*	23 29. 79 32.	Fixed and flashing light proposed on S.E. cay	4d	..	..	....
CAY LOBOS One fixed bright light	22 22.5 77 35.1	Iron tower, 130 ft. high, with black and white bands, on cay, N. side of Old Bahama Chan.	1a	146	16	1860
CROOKED ISLAND PASSAGE						
Bird Rock One rev. br. lt., 1½ m.	22 50.7 74 22.5	Stone tower, 112 ft. high, off N.W. part of Crooked Id. Rocks extend N. by W. ½ W. 1 mile from lighthouse	2b	120	17	1876
Castle Island One bright fixed lt.	22 6.7 74 20.7	Tower, 114 ft. high, white, with 3 red bands, ¼ of a mile within S.W. part of Castle Id.	2a	123	17	1868
GREAT INAGUA ID. One br. rev. lt., 1 min.	20 56. 73 40.8	Tower, 114 ft. high, white and red bands, 2 miles N.W. from S.W. point	2b	120	17	1870
TURKS ISLAND One br. revol. lt., ½ m.	21 31. 71 7.7	White iron tower, 60 ft. high, at 400 yards within N. end of the island	●	108	15	1852

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
Piedras Cay One fixed bright light	21 57.8 81 3.3	Brown tower, 26 ft. high, on N. part of cay. Guide to Cochinos Bay	4a	30	7	1863
Batabano One fixed bright light	22 41.4 82 18.3	Lantern, on a mast	..	31	3	1847
Isle of Pines *Proposed*	21 26. 83 6.	Proposed revolving light on Cape Pepe	2b	111	16	....
CAPE SAN ANTONIO One rev. br. lt., ½ min.	21 51.8 84 58.1	Roncali Tower, 107 ft. high, on the cape, W. point of Cuba	2b	107	20	1850
Jutias *Proposed*	22 43.3 84 6.5	Proposed fixed and flashing light	2c	..	..	....
Gobernadora *Proposed*	23 0. 83 13.2	Proposed revolving bright light on the point	2b	..	..	....
HAVANA One rev. br. lt. ½ min.	23 9.3 82 22.1	O'Donnell tower, 79 ft. high, on Moro Castle, E. side of entrance	1c	170	21	1847
Guanos *Proposed*	23 9. 81 42.	Proposed revolving bright light	3b	..	..	....
CARDENAS BAY						
Piedras Cay One fixed & flash. lt.	23 14.4 81 7.3	White tower, 67 ft. high. A red flash every 2 minutes	4d	74	10	1857
Cayo Diana One fixed bright lt.	23 9.9 81 7.	On an iron column	..	43	7	1862
Cruz del Padre One bright fixed light	23 17.1 80 54.2	White tower, 46 ft. high, on reef, ¾ mile N.E. from the cay. Reported to show a red flash for 10 secs., br. flash 30 secs., and dark 20 secs. in ev. min.	4a	49	10	1862
BAHIA DE CADIZ One rev. br. lt., 1 min.	23 12.6 80 29.3	White iron tower, 159 ft. high, on N.E. part of the cay	1c	175	24	1862
Port Sagua la Grande One fixed bright light	23 4. 80 4.	From a mast above a house, on N.W. point of Hicacal Cay, E. side of entrance	a	55	8	1872
CAY PAREDONE GRANDE One br. fix. & flash. lt.	22 29.4 78 9.7	White iron tower, 128 ft. high, on N. part. Flash every minute	1c	159	20	1859
NUEVITAS HARBOUR						
MATERNILLOSPOINT One fix. & flash. br. lt.	21 40.2 77 8.9	Colon tower, 170 ft. high. Flash every minute	1b	174	23	1848
Barlovento, or E. Point One bright fixed lt.	21 37.5 77 5.3	On a mast above a yellow house	6a	49	9	1864
LUCRETIA POINT One rev. *red* lt., 1 min.	21 4.6 75 37.9	Stone tower, on N.E. coast of Cuba	2b	112	10	1868
Baracoa One bright fixed light	20 21.7 74 30.3	On an iron column above keeper's house	a	48	12	1870
CAPE MAYSI One fixed bright light	20 15.1 74 10.3	Round tower on the cape, East extreme of Cuba	2a	128	17	1862

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
JAMAICA (English).						
MORANT POINT One rev. br. lt., 1 min.	17 56. 76 11.7	White iron tower, 96 ft. high, on E. extreme of Jamaica. Visible only betw. S.S.W. ½ W. and N.W. by N.	..	115	15	1842
KINGSTON						
Plum Point One fixed *red* or br. lt.	17 55.7 76 47.	White tower to N. of the point. Shows red from S.E. by E. ¾ E. southward, to S. ½ W.; thence bright over the shoals in the West part of Port Royal Bay up to N.W.	..	68	12	1854
Fort Augusta One fixed *red* or br. lt.	17 57. 76 53.	A lamp on the beacon. Light is red to East; bright to S. and W. Bearing N. by E. it leads through South Channel.	..	40	..	....
HAITI, OR SANTO DOMINGO						
SANTO DOMINGO One *red* and br. rev. light, 1 min.	18 28.1 69 52.5	Tower, 100 ft, high, on San José Fort. Lt. red and bright alternately. No lts. in Haiti to be depended on	4b	113	15	1853 1879
Jacmel Bay One *red* fixed light	18 12. 72 34.	On summit of white cliff. (Uncertain)	..	..	12	1867
Lamentin Point One *red* rev. lt., ½ m.	18 33.3 72 24.8	Circular white iron lt.-ho., 93 ft. high, 130 yds. W. of old lt.-ho., now demolished, S. shore of Port-au-Prince	3b	97	15	1880
Arcadins Islets One fixed bright lt.	18 47.5 72 38.3	Circular white iron lt.-ho., 31 ft. high, on N.W. extr. of centre Arcadins Island. N. side of Port-au-Prince Bay	5a	36	9	1880
Port Plata One rev. br. lt. 20 s.	19 49.2 70 41.2	N. Coast. Octagonal iron lt.-ho., 60 ft. high, 350 yds. S.S.E. from E. point of entrance	4b	137	14	1879
PUERTO RICO Fix. & flashing br. lt.	18 28.7 66 6.6	White iron tower on upper battery of Morro Castle. Fix. lt. with flash of 5 secs. ev. min.	3c	171	18	1846 1876
Port Ponce One fixed *red* light	17 58.8 66 39.5	Shown from a small square tower on Harbour-master's Office	..	39	10	1880
Mayaguez Bay	.....	Two red leading lights on mole head	..	..	..	....
SANTA CRUZ, or ST. CROIX ISLAND						
Frederichstæd One fixed bright lt.	17 42.7 64 52.7	Danish.] On Fort Frederichstæd	..	..	4	1857
Christianstæd One bright fixed light	17 45.4 64 41.5	On Louisa Augusta Fort	..	..	5	....
ST. THOMAS One fixed bright light	18 19.4 64 55.1	Danish.] On E. side of entrance, on Myhlenfelts Point. Visible from N. by E. by the West to E. by S.	..	95	12	1844 1872
SOMBRERO ISLAND One br. rev. lt., 1 min.	18 35.7 63 27.8	British.] Iron framework lighthouse, red, 132 feet high, on S.E. side of the island, ⅓ of its length from S. end	2b	150	20	1868
St. Martin Island One fixed bright light	.....	(Dutch.) Small lt. on old Fort Amsterdam, W. side of Grande Bay	..	150	8	1875
St. Christopher One fixed *red* light	17 18. 62 42.8	British.] On the beach at Basse Terre	..	37	6	1846
Montserrat One fixed light	16 42.2 62 13.	British.] Fixed lantern lt. for mail steamers, on the beach at Plymouth	..	..	..	....
Antigua						
English Harbour Two br., one *red* lt.	17 0. 61 45.3	British.] Fixed triangularly; upper lt. red, for mail steamers	..	62	8	1843
St. John Harbour One fixed bright lt.	17 6.8 61 54.5	Black wooden lt.-ho., 53 ft. high, on Sandy Id., off St. John Harbour	●	56	13	1875
Mariegalante One bright fixed light	15 54. 61 17.	(French)	..	..	9	1867

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
GUADALOUPE (French)						
Basse Terre Mole One *red* fixed light	16 0.2 61 44.8	On the mole. Also red lt. on end of wharf ...	..	..	2	1865 1870
Moule de Port One fixed bright lt.	16 20. 61 21.	Lamp light.....	..	..	7	1858
Pointe à Pitre One fixed light	16 13.5 61 29.5	Lantern, South of town. Lights on buoys when mail steamer is expected.....	..	..	..	....
Manroux Islet One fixed light	16 13.3 61 31.5	Lantern light	..	..	..	....
Gozier Islet One fixed bright lt.	16 11.1 61 29.	.....	..	..	..	....
PETITE TERRE One fixed bright lt.	16 10.5 61 5.1	Tower, 75 ft. high, near eastern part	3a	108	15	....
Dominica One *red* light	15 17.4 61 23.1	British.] On mole, on Roseau Point, for mail steamers	..	..	..	1867
MARTINIQUE (French).						
Caravelle Peninsula One fixed bright lt.	14 46.2 60 52.9	A white tower on Caracoli Mount, ½ of a mile inland of N.E. extreme of island.....	1a	410	12	1862
Pointe des Negres One bright fixed lt.	14 36. 61 5.5	On a red mast, on the fort	..	62	11	1855
Fort St. Louis One *red* fixed light	14 36.1 61 4.2	In S.W. part of fort. Lights on buoys when mail steamer is expected.....	..	131	6	....
Fort de France	.....	Fort Royal Bay. An electric lt. is shown from dockyard when mail steamers are expected. Be careful not to mistake this lt for Fort St. Louis lt. in thick weather	..	..	..	1880
Ste. Marthe Point One *red*, one coloured light	14 44.1 61 10.7	Red lt. to clear Milan. West lt. orange to N., green to S., blue to W. The white and blue lts. in line lead to the anchorage	..	..	5	1860
St. Pierre Bay	.....	Light on the edge of the bank, for mail steamers	..	..	..	1860
ST. LUCIA						
Castries One fixed *red* light One *red*, one *green* lt.	14 1.5 61 0.1	British.] Red lt. on Tapion Battery, South entrance of Castries Harbour; lt. for mail steamers. Red lt. on Vieille Ville Shoal; green lt. on Cocoa-nut Shoal	..	80	3	1843 1868
St. Vincent One fixed bright light	13 10. 61 15.	British.] On Fort Charlotte.	..	640	6	1858
Grenada One fixed bright light	.....	From Fort George flagstaff, St. George Harbour, when mail steamer is expected	..	..	3	1876
TRINIDAD One fixed bright light	10 38.7 61 31.9	British.] In Port Espana. Hexagonal tower, 43 ft. high, on the jetty. Shown seaward from S.W. to N.W.	4a	50	15	1841
Icacos Point One bright fixed lt.	.....	From a mast on S.W. point of Trinidad.....	..	39	5	1870
TOBAGO One fixed bright light	11 10. 60 44.	British.] At Scarborough. Pentagonal tower, 57 ft. high, red and white, on Bacolet, or Red Point. Leading lts. on two white beacons when mail steamer is expected.....	a	128	12	1842

Name and Character of Light.	Lat. N. Long. W. ° ′	Description, &c. (Bearings by compass from the light.)	Description of Apparatus	Height above H. W.	Visible in Miles.	Year established.
BARBADOS (British)						
Carlisle Bay	13 5.	1. On Needham Point. Bright to S. of E., red to N. of E. Reported bright all round	..	34	5	1855
1. One fix. br. or *red* lt.	59 36.3	2. Bridgetown. At the mole-head of the Carénage				
2. One fixed *red* lt.						
SOUTH POINT	13 2.7	Tower 90 ft. high, with red and white bands. Does not show until it bears to westward of S.W. by W. Kept well open, it clears the Cobbler Reef	..	145	..	1852
One rev. *red* lt. 1 m.	59 31.2					
RAGGED POINT	13 9.9	White tower, 97 ft. high, 300 yds. within cliff edge. Keep well to N.E. of light, to avoid Cobbler Rocks	2b	213	21	1875
One rev. br. lt., 2 m.	59 25.6					
ORINOCO RIVER LT.-V.	.....	Is withdrawn. A new one proposed	..	..	..	....
GUAYANA.						
CAYENNE (French)	4 56.2	1. Bright lt. on wood framework, N. of Fort Cépérou...	●	130	10	1863
1. One fixed bright lt.	52 14.8					
2. One fixed *green* lt.		2. Green lt. on Infantry Barracks. In one with br. lt., leads over Aimable Rock; keep to westward. Lt. obscured E. of N.E. ¼ N. ...	●	69	8	1850
3. One *red* light		3. On jetty	●	39	..	1862
SALUT ISLETS	5 16.7	On the summit of the hospital, Royale Islet ...	●	197	13	1864
One fixed bright light	52 35.					
Enfant Perdu Rock	5 2.7	Wooden framework, on rock, 6 miles N. ½ W. of Cayenne. Shown betw. S.W. by S. and E. by S. ¼ S., also betw. N.E. by N. and W. by N. ¼ N.	●	61	9	1864
One fixed bright light	52 21.3					
MARONI RIVER	5 42.5	1. (Dutch.) White pyramid-shaped structure, on Kaimar Head, W. side of entr. Lt. vis. between N. ⅝ W. and E. ⅜ N.	4a	75	10	1871
1. One bright fixed lt.	53 56.3					
2. One bright fixed lt.		2. (French.) White pyramid-shaped structure, on Français Point, E. side of entr. Lt. vis. betw. W. by S., through N., to E. by N. ...	4a	75	10	1871
Surinam Lightvessel	6 1.	(Dutch.) N.W. by N. from Bram's Point. Yellow ball at masthead	●	25	8	1858 1862
One fixed *red* light	55 16.2					
Berbice Lightvessel	6 29.2	(British.) Painted red; in 22 ft. water, 9 miles N.E. by N. from St. Andrew's Point. White flag, with red ball in centre, by day. Pilot sloop near.....	●	30	10	1850 1868
One bright fixed light	57 23.8					
Demerara Lightvessel	6 59.5	(British.) Painted red, one mast, N.E. by N. ½ N. 12 miles from lt.-ho. (When under repair, is replaced by a schooner).....	●	30	10	1844 1875
One bright fixed light	58 5.5					
DEMERARA RIVER	6 49.3	1. Octagonal tower, 100 ft. high, red & white vertical stripes, on East side of entrance ...	4b	103	16	1829 1864
1. One br. rev. lt., 1 m.	58 11.5	2. Shown from lt.-ho. in the direction of breakwater, between N. by W. and N.W.....	..	..	4	1879
2. One fixed *red* light						

SECTION III.

GENERAL OBSERVATIONS ON THE WINDS, TIDES, AND CURRENTS; AND ON THE DIFFERENT PASSAGES OVER THE NORTH ATLANTIC OCEAN.

1.—GENERAL REMARKS ON THE WINDS.

(1.) This book is intended as an introduction to the series which describes the six great oceans, of which it forms the first volume, and it therefore includes some topics which are common to them all, although there is no special reference to them in the other volumes. In the preliminary chapters, therefore, some general remarks on Ocean Meteorology are given at greater length than might be considered necessary in a special work like this; but as the greater number of sailors commence their work in the North Atlantic, they are offered to those who take interest in subjects more general than simple descriptions.

This science of Ocean Meteorology, whether as regards the phenomena of the atmosphere or of the sea, has been greatly elevated in importance of late years, especially since the time when the Conference at Brussels led to the establishment of the Meteorological Department of the Board of Trade, and to the co-operation of numerous allied institutions. But, once for all, it must be to Captain Maury that we should attribute the merit of initiating the topic in its new phase.

Since the development of the telegraphic system, which has enabled observers to collect and co-ordinate the various meteorological data from distant but connected stations, some remarkable results have been arrived at, which will be more fully entered into in the next section.

As the sailor deals not with speculation, but applies the facts of nature to his use, the mode in which the whole mass of the atmosphere is interchanged and mingled is important to him only as a field of observation which he enjoys with the rest of mankind. The present object being practical utility, the theories of the winds will be only briefly alluded to in this chapter, leaving the reader to those numerous and voluminous works now extant on these subjects for a more full elucidation of them.

(2.) As a broad and primary principle, it may be affirmed, the complete circulation of the atmosphere, by which any particle of the air has in its course passed over every portion of the earth's surface, is demonstrated by the fact that the air is composed of precisely the same elementary constituents in every part of the world. This fact was experimentally demon-

strated by the French Academy of Sciences many years since, who had bottles of air most carefully collected in all regions, and submitted to the most rigid analysis, which failed to discover any difference whatever. It is manifest in a natural sense, also, by its supporting animal and vegetable life universally in the same manner. If it were not so, the air over a special region would, in the course of ages, have become subject to the emanations and influences of the earth it covered. The same remark holds good, also, with the water of the ocean, equally universal in its definite characteristics, and from the same cause, as will be shown hereafter. The manner in which this is carried on is still involved in some mystery, although, as will be seen hereafter, these difficulties are disappearing before the rigid investigations which are now pursued and applied to each new fact as it arises.

(3.) In the year 1686, Edmund Halley* proposed the theory of the Trade Winds and Monsoons, which is now generally received as an approximation to the true solution. He afterwards altered his views, which were revised and extended by George Hadley, in 1735.† The following is a brief summary of them :—

(4.) The sun is constantly vertical over some part of the earth between the tropics, and this zone is consequently maintained at a much higher temperature than the regions nearer the Poles. This heat on the earth's surface is imparted to the air, which is, therefore displaced and buoyed up from the surface, and the colder, and therefore heavier air from without glides in on both sides along the surface ; while the displaced air, thus raised above its due level, and unsustained by any lateral pressure, flows over, as it were, and forms an upper current in the contrary direction, or towards the Poles; which, being cooled in its course, and also sucked down to supply the deficiency in the extra-tropical regions, keeps up thus a continual circulation.

Since the Equator revolves much more rapidly than the portions nearer the Poles, it follows, that a mass of air flowing towards the Equator must be deficient in rotary velocity, and, therefore, unable to keep up with the speed of the new surface over which it is brought. Hence these currents from the North and South must, as they glide along the surface, at the same time lag or hang back, and *drag upon* it in the direction *opposite* to the earth's rotation, *i.e.*, from East to West. Thus, from simple northerly and southerly winds, they become permanent *north-easterly* and *south-easterly winds.*

The lengths of the diurnal circles increase very slowly near to the Equator, and for several degrees on each side of it hardly change at all. It follows from this, then, that as these winds approach the Equator, their easterly tendency must diminish, and at the Equator must be expected to lose their easterly character altogether. And not only this, but the northern and southern currents, here meeting and opposing, will mutually destroy each other, leaving only the actions of local causes, which may lie in one region in one way, and in another a different one.

The result of this, then, is the production of two great tropical belts of north-easterly and south-easterly winds, while the winds in the equatorial

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* Philosophical Transactions, xvi., p. 153. † Ibid, 1735, p. 58.

belt which separate the two former should be free from any steady prevalence of an easterly character, and should also be comparatively calm. All these consequences are agreeable to observed fact, and constitute the system of the regular *trade winds*.

(5.) The constant friction of the earth upon the air near the Equator, it may be objected, would, by degrees, destroy the rotation of the whole mass; but it is compensated in this manner: the heated equatorial air, rising and flowing off toward the Poles, carries with it a rotatory velocity much greater than that of the surface over which it passes in its northward and southward progress. Hence it will gain more and more on the surface of the earth, and assume more and more a *westerly* relative direction; and when, at length, it necessarily returns to the surface in its circulation, which it must do, more or less, in all its course, it will act on it by its friction as a powerful S.W. wind in the northern hemisphere, and a N.W. wind in the southern, and thus restore the equilibrium. This is the origin of the S.W. and westerly gales so prevalent in our latitudes, and of the almost universal westerly winds in the North Atlantic.*

(6.) Now it will be seen that by this theory the trade winds *meet* near the Equator, leaving a belt of calms of various breadths between them. According to Commander Maury, the winds here being neutralized rise up, and *cross each other*; the wind brought by the S.E. trade passing over the N.E. trade as a S.W. upper current; and, having passed the calms or variables of the Tropic of Cancer, it appears as the ordinary anti-trade or S.W. prevalent wind. The chief physical fact upon which this theory is based is the red dust, found frequently to fall on vessels near the Cape Verdes, and in the Mediterranean, where it is called scirocco dust (as coming from the South). This red dust was found by Ehrenberg to consist of microscopic infusoria and organisations, whose habitat, *as far as was known*, is in South America. But this argument may be demurred to from the limited extent this dust falls upon compared with the vast area from which it is said to be derived.

(7.) There is another great difficulty in the reception of this theory, in

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* Sir John Herschel gives the following note in his work upon the origin of storms, which, as it is most feasible, we give here; it must be observed that it was written before the views and observations of Reid, Redfield, and others, had been published. We shall advert to it hereafter.

"It seems worth enquiry, whether hurricanes in tropical climates may not arise from portions of the upper currents prematurely diverted downwards before their relative velocity has been sufficiently reduced by friction on, and gradually mixing with, the lower strata; and so dashing upon the earth with that tremendous velocity, which gives them their destructive character, and of which hardly any rational account has yet been given. Their course, generally speaking, is in opposition to the regular trade wind, as it ought to be, in conformity with this idea.—(*Young's Lectures*, i, 704.) But it by no means follows that this must always be the case. In general, a rapid transfer, either way, in latitude, of any mass of air which local or temporary causes might carry *above the immediate reach of the friction of the earth's surface*, would give a fearful exaggeration to its velocity. Wherever such a mass would strike the earth, a hurricane might arise; and should two such masses encounter in mid-air, a tornado of any degree of intensity on record might easily result from their combination."—*Astronomy*, p. 132. The more recent views of Sir John Herschel will be found in their place hereafter.

the great breadth in some parts, of that intervening band of calms that these supposed currents are to cross each other. In the eastern part of the Atlantic it is from 300 to 600 miles in breadth. If this great interchange of directions were continually going on with such a vast amount of atmosphere, we may safely conclude that the lower strata would not be characterized by the calms or "doldrums" they are known by.

(8.) The more reasonable argument, in the present state of our knowledge, is, that the trade winds reaching this belt of calm, by far the greater part of this indraught will rise on its own side, and revert towards the Pole of its own denomination in a precisely opposite direction to that by which it arrived. In the parts of the equatorial regions, where this intervening calm belt is much narrower, as on the East coast of America, this crossing may take place, and the upper currents pass on towards the Poles of *contrary* names. At all events, this view of the circulation of the atmosphere will satisfy our present proposition—that every particle of air has been so commingled with the rest, that it produces the universality of character which is demonstrated to exist. These theories are practically unimportant to the sailor in his profession, but are highly interesting* to him as a subject of observation and reflection.

It has been held by many that the solar heat, combined with the revolution of the earth, is sufficient to account for the general phenomena of the winds; but there are still some difficulties in the way of accounting for some of the periodical winds which are found to recur with great regularity. This has been reasoned for by Mr. Hopkins, who argues that the trade wind at times blows towards areas of great condensations; in other words, that a great rain-fall occasions a corresponding indraught.†

It is also contended by some that as the lowest stratum of the air, having its velocity kept down by friction, generally moves from the tropical belts of high barometer to the regions of low barometer at the Poles and Equator. Thus, the N.W. and S.W. anti-trades constitute *under* currents toward the Poles beneath a topmast current, also toward the Pole and a middle return or compensating current; and that the crossing of the winds at the tropic is a physical impossibility.‡

Another view of the cause of atmospheric circulation is that by Professor Laughton, of Portsmouth, who contends that it is due to aëro-tidal or mechanical causes.

He supposes that the prevailing westerly wind of high latitudes is caused

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* See further on these subjects, Maury's "Physical Geography of the Sea, 1860," pp. 149, 175. Sir John F. W. Herschel, Ency. Brit., 1859, xviii., 577.

† Mr. Hopkins: "The atmospheric changes that produce Rain and Wind;" also see Journal of the Royal Geographical Society, 1856, pp. 158, et seq. See also D. Vaughan, U.S., in British Association Report, 1860, p. 41. This view of Mr. Hopkins is modified by other observations, which will lead to the inference that currents of air move *around* areas of high or low pressure, the latter condition being that which usually attends the greatest rain-fall. This is adverted to presently.

‡ See Professor J. T. Thomson, in Report of the British Association, 1857; and Professor J. D. Everett, in the same Journal, 1871, p. 54. A vast mass of data is given in Professor James H. Coffin's "Winds of the Northern Hemisphere," hereafter quoted.

by the influence of the moon, and that the modifications of this wind, caused by the coasts which bound the sea, are the sources of all other winds. For instance, he says when our westerly wind strikes the coast of Portugal, it will branch to the North and South as any fluid would do under similar circumstances, and that eventually it will recurve to the westward to fill up the space from which the air forming the original westerly wind, had moved. Thus eddying, as it were, in two great circuits, and carrying the surface waters with it, causing the main currents of the ocean.*

There can be no doubt that land frequently offers an obstruction to a current of air, and diverts its course, but this theory does not take into account the changes which come with the seasons; they seem to be due to temperature.

(9.) There is one feature of the atmosphere which has been involved in some obscurity, or, at least, has been the subject of controversy. It is the condition of *aqueous vapours*, at all times present in the air. It is a very important question, as upon this water-bearing property of the air, evaporation, condensation, and rain depend, and consequently climate and fertility to the earth. The doubts may be briefly stated. The eminent chemist, Dalton, demonstrated that one gas (and aqueous vapour is such) could permeate or exist in connection with another gas without displacing its bulk, and that water was thus diffused through the atmosphere without increasing its volume. Therefore, in estimating the height of the barometer, account must be taken of the amount (or weight) and elasticity (or tension) of the vapour, and *subtracted* from the height of the mercury, to give the true weight of the dry air. With a dew point temperature of 87.35°, the pressure of moisture is equal to the weight of 1.26 inches of mercury, and must be *subtracted* from the height shown by the barometer, as before stated. This was the view held by Dalton, Ure, Regnault, Daniell, Sir Henry James, Alexander Buchan, &c.

In opposition to this, Professor Patton, of Bombay maintained that moisture did *displace* an equal or equivalent volume of air, and that, therefore, it was only the difference of their amount which should be applied as a correction, and he estimated the amount of vapour above stated to be equal to a pressure of only 0.518 of an inch of mercury. But the first theory is thought to be the most feasible.†

(10.) Leaving the field of conjecture, we come to the actual condition of the atmosphere which covers the North Atlantic Ocean in particular, and generally the whole earth. Its elevation, or weight, is ascertained by the barometer, as is well known. According to the decrease in the height of the mercury on ascending to great elevations, it is calculated that at 15 miles the air is rarefied to about 25,000 times, and at 80 or 90 miles a perfect vacuum exists. It presses with a mean force of 14.73 lbs. per square inch, and forms one 1,125,000th part of the mass of the whole earth. The trade

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* "Physical Geography in its relation to prevailing Winds and Currents."

† See "Abstracts of Meteorological Observations by the Royal Engineers, 1853-4," by Sir Henry James, R.E., F.R.S.; "The Handy Book of Meteorology," by Alexander Buchan, M.A, 1868, pp. 160—162; also, the later works of Professor Tyndall.

winds do not reach more than to 3 miles in height, and it is probable that all the phenomena of clouds and vapour occur beneath the height of 4 to 5 miles.

(11.) If the surface of the earth were evenly covered with land or water, or a combination of both, the phenomena of the trade and anti-trade winds would form symmetrical zones around the globe; but the relative proportions are very different in the two hemispheres, being 100 land to 150 water in the northern, and 100 to 628 in the southern.* There is a still greater contrast, if we take the horizon of London as a great circle dividing the earth into two hemispheres. It will be then seen that London is in the centre of that half which includes all the land, except Australia; and the other half all the water of the globe. From this cause the line of meeting between the N.E. and S.E. trades is in all seasons *northward* of the equator in the Atlantic; and, from the land influences on the trade winds to the N.E. of Africa, there is a wide space of calms, or doldrums, whose base lies against that continent, and its apex stretching toward the Coast of Brasil, as is readily seen by the illustration of the trade winds diagram, which will explain far better this peculiarity than a verbal description.

(12.) The *force* with which the wind blows is the chief consideration of the sailor, in connection with the study of the subject. This force is readily measured in a fixed observatory, or on board a ship at anchor; but not so when she is under sail, as it is manifest that she is then apparently feeling less wind than is actually blowing, from being drifted before it. We have had some singular accounts of some of the fine clipper ships scudding at an immense rate before a gale, which has been marked as of no extraordinary violence; while other ships, dull sailers, have been dismasted or disabled by the fury of the same gale, from their not being able to bear away before its great velocity. Therefore, the *recorded* force of the winds met with at sea should be subject to this qualification—what are the sailing powers of the ship which has recorded them? It is manifest that a vessel, and especially a steam-vessel, will estimate the force of the wind acting on her in exact proportion to the direction she is meeting it or running before it. Thus, a vessel of good sailing power going before the wind, which, while stationary, she would estimate as having the force of 4, and running 5 or 6 knots before it, it will appear only to have a force of a light breeze, or 3 knots; while if a steamer went 10 knots against, it would appear to blow with a force of 7, or as a fresh treble-reef topsail wind. We have no *standard* of sea-rates for the wind as yet. Perhaps it would add to the value of such observations if the sailing powers of all ships engaged in adding to our knowledge were tested when both close hauled and running free upon a wind of known velocity.

In former times the vague terms of breeze, gale, hurricane, &c., sufficed to describe the relative character of the wind. The late Sir Francis Beaufort devised a system of simple notation which more exactly defined these forces, and which is now in universal use at sea. The figures prefixed indicate the estimated character of the wind:—

* The dry land, as far as it is known, is estimated to occupy 49,806,000 square statute miles. If this is increased to 51,000,000 for the unknown polar regions, it will allow 145,000,000 of square miles to be covered by the ocean.—*Sir J. Herschel.*

(*Beaufort Notation.*)

0. Calm.
1. Steerage way.
2. Clean-full from 1 to 2 knots.
3. „ 3 to 4 knots.
4. „ 5 to 6 knots.
5. With royals ("close-hauled").
6. Topgallant sails over single reefs.
7. Two reefs in topsails.
8. Three reefs in topsails.
9. Close reefed topsails and courses.
10. Close reefed maintopsail and reefed foresail.
11. Storm staysails.
12. Hurricane.

From 2 to 9 being supposed* close hauled.

(13.) The wind over the land is found to be generally of much less force and velocity than at sea, so that the Beaufort notation was found inconvenient for land purposes; Mr. Glaisher, therefore, has proposed another notation for this use, which is now adopted at Greenwich, Liverpool, and indeed at most of the principal observatories. It divides the force into the numbers 1 to 6, which have been proportioned to the Beaufort scale as follows:—

(*Glaisher Notation.*)

1. Moderate (Beaufort scale .... 1—2)
2. Fresh („ .... 3—4)
3. Strong („ .... 5—6)
4. Heavy (Beaufort scale .... 7—8
5. Violent („ .... 9—10)
6. Tremendous („ .... 11—12)

(14.) The actual force and velocity of the wind has been calculated by Sir W. Snow Harris, by an improvement of Lind's Anemometer, by which he found air moving 20 feet in a second presses on 1 square foot with a force of about 13 oz. avoirdupois, or at 50 feet per second it would support a column of water 1 inch high, the pressure force increasing very nearly with the square of the velocity. With these data the table on the following page has been calculated:—

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* In addition to the *figures*, showing the force of the wind, the state of the weather is to be understood by *letters*, as follows:—

Letters indicating the state of the Weather (*Beaufort Notation*).

b Blue Sky.
c Clouds (detached).
d Drizzling rain.
f Foggy.
g Gloom.
h Hail.
l Lightning.
m Misty.
o Overcast.
p Passing Showers.
q Squally.
r Rain.
s Snow.
t Thunder.
u Ugly (threatening) appearance of Weather.
v Visibility. Objects at a distance unusually visible.
w Wet (Dew).

Note.—A bar (—) or dot (.) under any letter augments its signification:—thus f very foggy, r heavy rain, r heavy and continuing rain, &c., &c.

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TABLE,

Showing the Force and Velocity of the Wind from light Airs to heavy Gales and Tempests.

Pressure in lbs. on Square Foot.	Velocity.		Popular Descriptions.
	Feet per Second.	Miles per Hour.	
0 002	1	0.68	Gentle airs (unappreciable by guage). (*Beaufort Scale*, 1.)
0.004	1.47	1	
0.019	3	2	Light airs (just appreciable by guage); would fill the lightest sail of a yacht (2).
0.032	3.9	2.66	
0.043	4.5	3	
0.065	5.28	3.8	Light breezes, such as would fill the lightest sails of a large ship (3).
0.071	5.87	4	
0.090	6.6	4.5	
0.100	6.98	4.75	
0.112	7.34	5	
0.130	7.89	5.38	
0.162	8.8	6	
0.228	10.4	7	
0.260	11	7.6	
0.291	11.8	8	Moderate breezes, in which ships can carry all sail (4).
0.364	13.2	9	
0.390	13.6	9.27	
0.452	14.7	10	
0.521	15.8	10.77	
0.551	16.2	11	
0.650	17.66	12	
0.780	19.3	13	Fresh breezes,—topgallant sails and royals (5).
0.830	20	13.6	
0.884	20.6	14	
0.910	20.9	14.25	
1.042	22	15	
1.170	23.6	16	
1.250	24.2	16.5	
1.302	25	17	Fresh winds; reefs (6).
1.470	26.5	18	
1.563	27.39	18.67	Strong winds; treble-reefed topsails (7).
1.630	28	19	
1.790	29.35	20	
2.084	31.15	21.47	Gales; close-reefed topsails and reefed courses (8).
2.600	35.32	24	
3.126	38.73	26.40	Strong gales; close-reefed topsails and stay sails (9).
3.647	41.83	28.52	
4.168	44.83	30.56	
4.689	47.44	32.34	
5.200	50	34	Heavy gales and storms (10).
7.800	61.18	41	
10.400	70.72	48.2	
13.000	79.07	53.91	
20.800	100	68.18	Very heavy gales; great storms; tempests (11).
26.000	111.74	76.18	
31.200	122.62	83.6	
41.600	141.30	90.34	Tornadoes; cyclones; hurricanes (12).
52.000	157.98	107.7	
62.400	173.06	120	

There is no question that the figures in this table may be open to some doubt, as the subject is a difficult one, and they are given independent of the different forces exerted by aqueous vapour and by air. Sir Henry James has also given a table, more complicated, but which does not very materially differ from those just given, which will suffice for the sailor's use.

(15.) In estimating the *diminishing* pressure on the barometer during the progress of a gale, it is rather difficult to understand how the force which must, in some degree, *compress* the air, and therefore make it more dense and heavy, besides the idea that such a force may tend to heap up the atmosphere in some part of the area, can show a *less* weight of air. There is one view which has not been made prominent — that the *horizontal* force exerted by the progress of the wind may lessen its downward vertical force or pressure, in the same way that a railway train in quick motion does not deflect a bridge as the same train would do if going slower; or as a skater can pass swiftly over ice that would infallibly break with his weight when quiescent; or as the apparently anomalous loss of gravity in the gyroscope when in motion. However, these considerations have no effect on the phenomena of a falling barometer with a rising wind.

(16.) *The alternation of the sea and land breezes* in warm latitudes is an important feature in coast navigation. Its cause is generally well understood. It is owing to the different powers of radiation and absorption of heat possessed by land and water. So that, generally, when the day temperature is highest on the land, the strongest will be the alternating breezes. During the day the radiation of the sun's heat on the land causes the air to expand and rise from the surface, and then the sea air rushes in to fill the void. It frequently occurs that the surface of the soil will show a temperature of 120° under the meridian sun, and sinks to 50° or 60° during the night, while the sea, rarely having a higher temperature than 80°, and from being a bad radiator fluctuates but very little, it follows that it is alternately warmer and colder than the land, and hence the phenomena in question. The minimum temperature of the twenty-four hours being a little before sunrise, and the maximum about 2 p.m., the change of these breezes occurs generally at some little time after those hours.

(17.) The wind decidedly veers round to the compass according to the sun's motion, *i.e.*, from North through N.E., East, S.E., to South, and so on, often making a complete circuit in that direction, or more than one in succession (perhaps occupying many days in so doing), but it rarely backs, and very rarely, or never, makes a complete circuit in the contrary direction. This has been shown by Professor Dové to be the direct consequence of the rotation of the earth; and, although the observation was recorded by Lord Bacon, in 1600, it is now known as *Dove's Law of Gyration.**

(18.) Professor Coffin, from his elaborate discussions, thinks himself authorized to lay down, as a general description of the winds of the northern hemisphere,—1st. That from high northern latitudes the winds proceed in a southerly direction, but veer towards the West as they approach a limit

* When speaking of the wind veering with the sun, of course the shifting of the cyclonic winds in the northern hemisphere is not included.

ranging from about lat. 56° on the western continent, to about lat. 68° or the eastern, where they become irregular and disappear. The area of this zone is about 11,800,000 square miles. 2nd. That farther South there is a belt of westerly winds, less than 2,000 miles in breadth, entirely encircling the earth; the westerly direction being clearly defined in the middle of the belt, but gradually disappearing as we approach the limits on either side. The area of this zone is estimated to be about 25,870,000 square miles. 3rd. That South of the zone last named the mean direction of the wind is easterly. This area is estimated to contain 60,760,000 square miles.* Professor Dové contends that there are but two systems, the 1st and 3rd of the foregoing.†

(19.) The *wind regions* of the North Atlantic may be thus defined:—To the North of the Tropic of Cancer are the *Anti-Trades*,‡ or *Passage Winds*, which, though variable, have a general N.E. tendency. South of these is a belt of calms and variable winds, distinguished by a high barometer, called by Commander Maury the "*Calms of Cancer*," known to sailors as the "horse latitudes." This belt varies between 30° and 35° North, according to the season. South of this, and extending to about 8° to 5° North, but varying in its southern as in its northern limits, is the great region of the *N.E. Trades*. In the space between the Equator and this region of trades are the "*Doldrums*," or calms, of the Equator; and upon the African coast there is a regular alternation of the winds, similar to the monsoons in other parts. Each of these regions will be treated of separately.

(20.) In the spaces which separate these wind systems those hurricanes, tornadoes, typhoons, or cyclones occur, which are caused by the action of currents of air moving in opposite directions; their phenomena are further controlled by the influence of the land they approach or pass over. This important branch of the present subject is fully considered hereafter, but the occurrence of storms is an exceptional case in the vast system of atmospheric circulation we have been considering.

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* "Winds of the Northern Hemisphere," by Professor Coffin, A.M., Pennsylvania, U.S., in "Smithsonian Contributions to Knowledge," vol. vi., 1854.

† See Report of the British Association, 1845. See, also, Professor Mitchell in the American Journal of Science and Arts, vol. xix., p. 254. A great amount of information will be found on the general subject in the works of Kämtz and Romme, who have also laboriously studied and generalised the phenomena of the winds, and to whose labours much that is here said is owing. But by far the largest collection of observations, arranged in order, is contained in Captain Maury's "Pilot Charts," before alluded to, which are well known to all sailors.

‡ This term, "Anti-Trades," is adopted by Sir John Herschel. It is expressive and appropriate. By others they have been named *Counter-Trades*, which designation may more exactly define the upper currents *over* the trade winds. They have also been vaguely called "The Variables," a term which is best confined to the characteristic of the belts of calm or shifting winds about the Tropics.

2.—THE MOTIONS AND PRESSURE OF THE ATMOSPHERE.

(21.) The intimate connexion between the fluctuations of the barometer and changes in wind and weather is familiar to all. As Mr. Piddington says, "The commander who is watching his barometer is watching his ship, and that in the most efficient manner." This remark has a greater force now than when it was first made; because, since that period, the sailor has greatly extended the use of the Aneroid barometer, which, by its immediately showing any atmospheric change, gives a longer and more assured warning. The mercurial barometer used at sea, from having its column much contracted in one part to overcome the "pumping" action which the vessel's motion would cause, is much more sluggish, and hence it may not indicate a change till a part of its predictions has passed over.

(22.) But the isolated observation of barometer and other indications of the condition of the atmosphere which can alone be made at sea, are of infinitely less value in guiding the sailor than are those made within the range of the stations from which weather reports are sent to each other, and by a comparison of which many very important conclusions can be arrived at; and it is this minute examination and comparison of the varied state of the meteorological conditions existing at one and the same moment at stations widely separated and extending over the N.W. of Europe that some remarkable laws have been arrived at, and great advances made in the general subject of atmospheric meteorology.

(23.) But, as said before, although this method of comparison is not applicable to the ship at sea, yet it is thought that the method by which "weather predictions" are made—the reasons why barometric pressures indicate certain general facts—why land disturbances from heat and cold—why differing temperatures in sea water bring about, or point to, great and broadly-marked differences in wind and weather—are proper subjects for the sailor's study, and, as such, are not out of place here.

In laying as briefly as we can the results lately arrived at by the various observers, or by a combination of their deductions, we will use the language of the authors themselves, referring to the works quoted for more extended information.

(24.) When the cyclone theory was propounded, which was in the first place done by Mr. Redfield, then by Sir W. Reid, Mr. Piddington, Dr. Thom, and other pioneers in this all-important subject, the "law" was established that these hurricanes in the northern hemisphere, having a low barometer in their centre of the vortex, will have this centre or vortex on the *left hand* of any one standing on its circumference with his *back* to the wind, the case being reversed in the southern hemishere.

In the further investigation of the laws which govern the movements of the air, which was consequent on the recommendations of the Brussels Congress, the Dutch nation, which it is well known is foremost in the rank of enquirers, established an Observatory at Utrecht, the Royal Meteorological Institute of Holland; and in this place Dr. Christopher H. D. Buys-Ballot pursued for several years an enquiry into the data afforded by the daily weather telegrams which were sent to this Observatory from several parts of

the kingdom, and he arrived at the very important conclusion that the same law which was established by Redfield and Reid in regard to the local meteors, known as cyclones, is applicable, on the very much broader scale, to the whole system of winds over the whole of the globe. But confining the remarks to the northern hemisphere, and more particularly to Holland, Professor Buys-Ballot determined the law which is known by his name, which is briefly stated in these words:—

Buys-Ballot's Law.

> If, on any morning, there be a difference between the barometrical readings at any two stations, in Holland, a wind will blow on that day in the neighbourhood of the line joining those stations, which will be inclined to that line at an angle of 90°, or thereabouts, and will have the station where the reading is lowest on its left-hand side.

(25.) Dr. Buys-Ballot explained this law, and the reasons for propounding it, and its application to an apparatus, termed an Aëroclinoscope, for the purpose of indicating, each morning, at each port in Holland, the wind which may be expected to blow there during that day, in a pamphlet, published in 1860.* A further exposition of it was published, in English, in 1863, by Captain F. H. Klein.†

This law is the same as that which is known to hold in the case of tropical cyclones, and has also been proved to be true in the case of winds in these latitudes, by Dr. Lloyd, in his "Notes on the Meteorology of Ireland," published in 1854. However, Professor Buys-Ballot has been the person who has insisted on its importance as a means of foretelling wind, both as to direction and force.

(26.) The further investigation of this law, and its application to weather predictions, have been vigorously carried on by Captain Henry Toynbee, F.R.A.S.—a name well known to seamen—since his connexion with the Meteorological Office; and in his Report on Isobaric Curves, 1869, he makes the following remarks on the general subject.

"Whilst considering Buys-Ballot's law, I have been struck by a few facts which seem to indicate its relation to the general circulation of the air in moderately high latitudes. Here it may be well to repeat that law, viz., 'If you turn your back to the wind (however light) in the higher northern latitudes, there will be a lower pressure to your left than to your right hand.' This order is reversed in the southern hemisphere; hence it is probable that as the equator is approached the wind will blow more directly from a high towards a low pressure.

"With regard to the winds of the northern part of the North Atlantic, it is known that during our winter a high barometer exists over the cold land in Europe and America, whilst it is relatively low over the sea, hence the prevalence of strong south-westerly winds on our side of the Atlantic, and

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* Eenige regelen voor aanstaande Weersveranderingen in Nederland voornamelijk in verband met de dagelijksche Telegraphische seinen. Utrecht, 1860.

† "The Foretelling of the Weather in connexion with Meteorological Observations," by F. H. Klein. Translated by A. Adriani, M.D., 1863.

north-westerly winds in Newfoundland, as given in Mr. Buchan's work.* (See his Chapter on Winds.)

"These winds work round an area of low pressure over the water, which seems to account for the prevalence of north-easterly winds in Greenland.

"Then, as spring advances, the air over the land becomes heated, causing the barometer to fall, whilst water, changing its temperature much more slowly, does not act so quickly on the air above it, and the result is that a higher barometer sometimes exists over the water than over the land, which is probably the cause of so much north-easterly wind at that season in England.

"Again, to the northward of the N.E. trades in the calms of Cancer, there is a very high borometer which does not extend up to the land of Africa or America (see the French 'Atlas des Mouvements Generaux de l'Atmosphère'); it is also well known to seamen that this area of high barometer extends farther North in the summer, which, taken into consideration with the heated land and consequent lower pressure on the coasts of Spain and Portugal, seems sufficient to account for the northerly winds on those coasts. The N.W. wind, which so very generally precedes the N.E. trades with ships outward bound from England, seems to result from the draught of air, in accordance with Buys-Ballot's law, between this area of high pressure and the lower pressure to the East and N.E. of it. For the same reason the south-easterly tendency of the N.E. trades on the western side of the Atlantic, between 20° and 30° N. (see the Admiralty Pilot Charts for the Atlantic Ocean), is probably due to the air drawing round this area of high pressure. In fact, it seems most probable that this area of high pressure is a perpetual 'anti-cyclone,' the name given by Mr. Francis Galton, in his 'Meteorographica,'† to patches of high pressure round which the wind revolves in a contrary direction to that of a cyclone, which is an area of low pressure; and that this area of high pressure is a downward current of air which has overflowed from the various high temperatures and low pressures around it, out of which the air seems to issue in various directions, being governed by the neighbouring low and high pressures; whilst in it there is a large extent of equal pressure and consequent calm (the 'horse latitudes') which should be avoided by sailing ships as a kind of atmospheric shoal. It will be noticed that the route of West India hurricanes is round this area of high pressure. The effect of the earth's revolution upon these downward and upward currents of air is supposed to be the cause of their revolving in contrary directions. We are now working up the meteorological data for that part of the Atlantic between 20° North and 10° South, and I notice that in the winter there is a tendency for the N.E. trades to draw to the S.E., on the south-western side of the Cape Verde Islands, which probably arises from the air being cooler and heavier over the land, thus bringing Buys-Ballot's law into play to deflect the wind.

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* "A Handy Book for Meteorology," by Alexander Buchan, Secretary to the Scottish Meteorological Society, Second Edition, 1868.

† "Meteorographica," by Francis Galton, F.R.S., F.R.G.S.—Macmillan & Co.

"It is well known to those who navigate the South Atlantic, that an outward bound ship on the western side of that ocean has a N.E. wind towards the southern verge of the S.E. trades, whilst a homeward bounder in the same latitude, but near to Africa, has a S.W. wind. These winds seem to result from the same cause, which has been alluded to in the North Atlantic, viz., an area of high pressure over the central part of the ocean, which decreases as you approach the land on either side. My paper 'On the Normal Circulation of the air, &c.,' published in the proceedings of the Royal Society, June 15, 1865, shows that the low pressure does exist just to the West of South Africa.

"In the proceedings of the Meteorological Society, February 17th, 1869, are given 'Results from Meteorological Observations, made at the Royal Observatory, Cape of Good Hope, for twenty years, by Sir T. Maclear,' which show that the barometer is from two to three-tenths higher in their winter than in their summer. Now it seems very probable that there is not a corresponding change in the pressure over the warm water to the South of Africa, which would cause an increased barometer difference; and therefore, according to Buys-Ballot's law, an increase in the force of the westerly winds.

"The same law probably holds good off Cape Horn; and as we suppose that a higher pressure sometimes exists over the South Shetlands and Graham's Land, than over the water to the North of them, Buys-Ballot's law would require that easterly winds should be more common in the neighbourhood of that land than near Cape Horn, as experienced by Capt. James Gales. (See an account of his beating round the Horn, in my 'Report to the Committe on the Meteorology of the North Atlantic.'—No. 2 of this series.)

"This intimate relation between barometer differences and the direction and force of wind increases the value of barometer observations, for it is clear that when their relation is better established, we shall be able to form a good estimate of the one by knowing the other, and the method now adopted in the office of sifting all our data into one degree squares for each month will, it is hoped, enable us to draw monthly isobarics for important parts of the sea, which will be related to the direction and force of the winds prevailing in each month. Such work for a few of the important squares near the Cape of Good Hope and Cape Horn will show where the barometer difference is least in a given distance, and as a consequence where the wind is generally most moderate, whilst the direction in which the isobarics run will show the direction of the prevailing wind, helping the navigator to decide on the best route. Seamen, who fear a calm more than a gale, will be glad if we can give them the monthly positions of the different areas of high and equal pressure where there are calms, in order that they may avoid them."

Capt. Toynbee's investigations will be further alluded to presently.

(27.) Barometric Waves.—In 1843, the late Sir John Herschel presented a report to the British Association on the result of some investigations he had made into the barometric changes registered at the term-days of the equinoxes and solstices, and arrived at the following conclusions:—

"1. We have succeeded in tracing distinct barometric waves of many hundreds of miles in breadth over the whole extent of Europe. Not only the breadth, but the direction of the front and the velocity of the progress of such waves have been clearly made out.

"2. Besides these distinctly terminated waves, we have been able, if not to trace the rate and law of progress, at least to render very evident the existence of undulating movements of much greater amplitude, so great indeed as far to exceed in dimension the area in question, and to require much more time than the duration of a term-series (36 hours) for their passage over a given locality. At the same time it must be recollected that the records of every meteorologist bear ample testimony to this conclusion in the fact of long-continued rises, falls, and stations (both high and low) of the barometer continuing for many days or even weeks.

"3. In Europe, Brussels is clearly entitled to be regarded as a point of comparatively gentle barometrical disturbance. Very *deep* waves it is true, and very extensive ones ride over it; but with regard to smaller ones it may be regarded as in a certain sense a nodal point where irregularities are smoothed down, and oscillatory movement in general is more or less checked; and such movements increase in amount as we recede from Brussels as a centre, especially towards the N.W. as far as Markree."

(28.) Mr. W. R. Birt, in the further enquiry into the subject of barometric waves, as reported to the British Association, between 1843 and 1848, established in the year 1846 the fact that each wave is accompanied by two streams of air, constituting two oppositely directed *winds;* and it is not a little interesting to remark, in passing, that this discussion although unaccompanied by the actual projection either of barometric gradients or isobars, anticipated them both, inasmuch as the heights of the barometer are so arranged as to serve all the purposes of projected isobars and the determination of gradients, and this was effected as early as 1844, by barometric heights being treated *geographically*—an essential element of the isobar.

It will be needless to follow the progress of this subject through all its stages, but this will suffice to show that this important topic was investigated when the means of doing so were much more difficult to obtain, and that some of the decisions now accepted were clearly pointed out in former times.

In the course of Mr. Birt's researches on atmospheric waves, he had an opportunity of testing the correctness of Professor Dové's suggestion, which he found to be in close accordance with the truth, for he not only ascertained the existence of the S.W. and N.E. compensating currents, but also that of another set of oppositely directed and compensating winds at right angles to them. These were N.W. and S.E., with a lateral motion towards the N.E. He also carefully discussed the barometric phenomena with relation to both these sets of currents, and arrived at conclusions which the reader will find in detail in Mr. Birt's third report, presented to the British Association for the Advancement of Science (Report, 1846, pp. 132 to 162), but which may be briefly enunciated as follows:—During the period which

passed under the examination of the writer, he found the barometer generally rising with N.E. and N.W. winds, and that as a maximum or *highest* reading of the mercury approached, the wind died away mostly to a calm. On the other hand, with S.W. and S.E. winds, the barometer generally fell, the force of the wind proportionally increasing until the mercury passed its minimum or *lowest* reading.

A most interesting instance of an atmospheric wave traversing Europe from the West of Ireland to the Black Sea is recorded in the French serial work, "Cosmos." In the "Mercantile Marine Magazine" for May, 1856, we find a notice of the occurrence of an atmospheric wave in the Indian Ocean between 40° and 50° South latitude, and 44° and 56° East longitude.

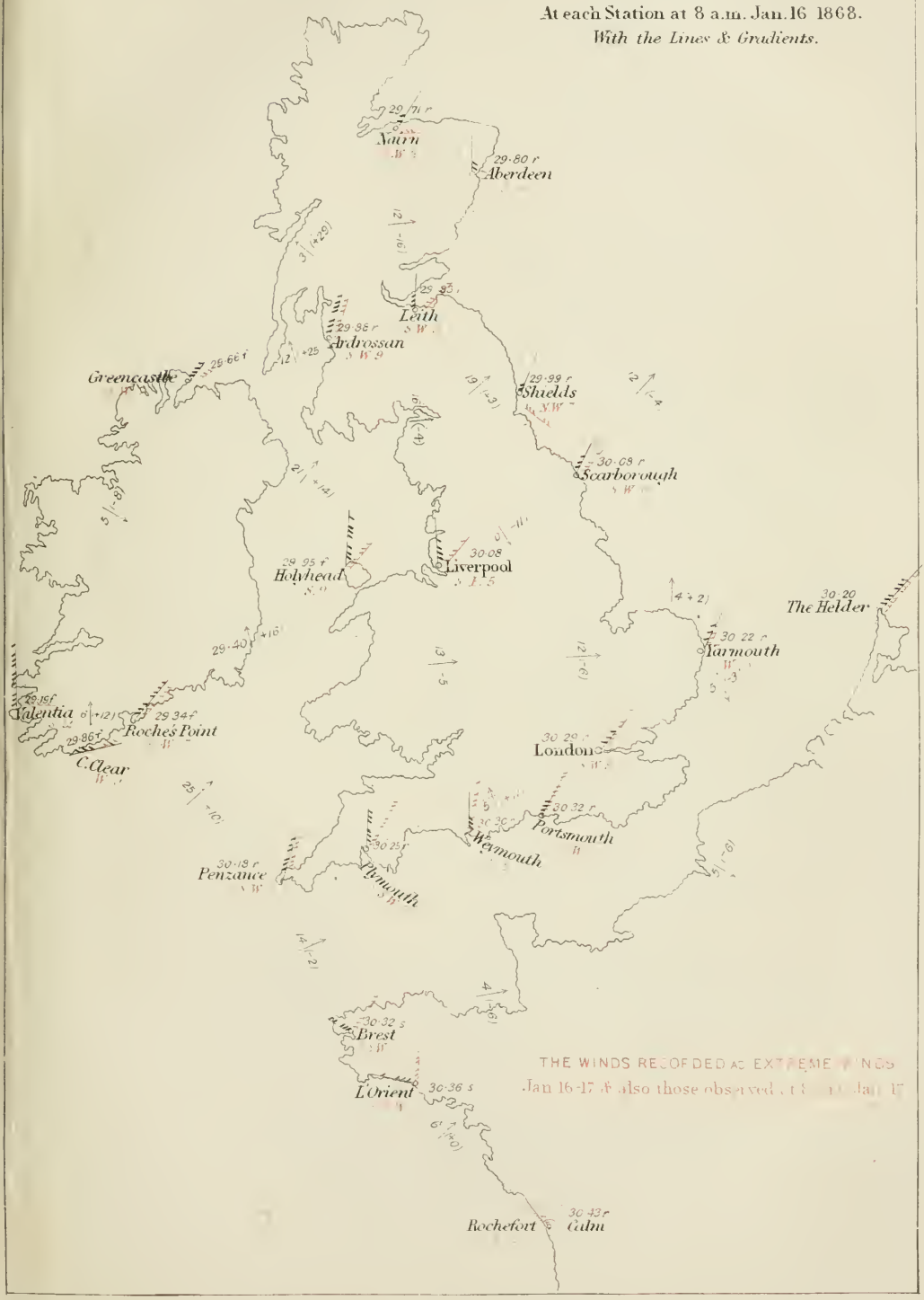
There is one important feature which the study of the barometer has brought to light, and which is by no means devoid of significance, viz., that its oscillations are much greater in the neighbourhood of water; thus it appears that the junction lines of land and water form by far the most important portions of the globe in which to study atmospheric waves; for, in the great systems of European undulations, it is well known that these oscillations increase, especially towards the N.W., and the late Professor Daniell has shown from the Mannheim observations that small undulations, having their origin on the northern borders of the Mediterranean, have propagated themselves northward; and in this manner, but in a smaller degree, the waters of the Mediterranean have contributed to increase the oscillations of the barometer, as well as the larger surface of the Northern Atlantic. From such considerations as these it becomes very desirable that our knowledge of the rise and fall of the barometer, in immediate connexion with the direction and force of the wind on the surfaces not only of our large oceans, but also of those of our inland seas, and especially in the neighbourhood of extensive archipelagoes, should be increased.

(29.) In a future page, in the section devoted to a description of the winds encountered in the northern part of the Atlantic, this subject of atmospheric waves will be again adverted to; and then it will be more plainly seen how it is applicable to the daily experience of the navigator.

(30.) Barometric Gradients.—The primary principle, that the atmosphere moves in a series of waves, indicated by the high or low pressure of the barometer, having been established, the next step was to estimate the dimensions of these waves, and the relation of this element to the changes in the wind's direction and force. In this enquiry several observers have recorded the results of their work. Besides Mr. Birt, before mentioned, Dr. Lloyd, in his "Notes on the Meteorology of Ireland, 1854," and several other gentlemen, we have the proposition of Mr. Thomas Stevenson, C.E., in 1867,*

* "Mr. Stevenson measures his gradients as an inch of mercury in a variable number of miles. I measure mine as a variable number of hundredths of an inch of mercury per 100 miles. Mr. Stevenson's paper contains, as far as I am aware, the first proposal to estimate the intensity of storms *numerically*. It was read at the meeting of the society of June, 1867, and printed in the 'Journal of the Scottish Meteorological Society' for January, 1868."

BAROMETRICAL READINGS
AND THE
WINDS OBSERVED
At each Station at 8 a.m. Jan. 16 1868.
With the Lines & Gradients.



THE WINDS RECORDED AS EXTREME WINDS
Jan 16-17 & also those observed [illegible] Jan 17

to define the dimension or magnitude of these atmospheric waves as "*Barometric* gradients," a term since adopted by the Meteorological Office. Its further development, and the application to weather predictions, have been carried out by the superintendents of that office, R. H. Scott, Esq., M.A., the Director, and Captain H. Toynbee, the Marine Superintendent of the Meteorological Office. As is well known, the system of announcing the probability of a coming storm, which was inaugurated by the late Admiral FitzRoy, was abandoned, it may be well to briefly allude to the system now in use, and this will be best done by quoting the words of the report,* by Robert H. Scott, Esq.

"In order to test the truth of this law as applied to our own daily weather reports, and its value as indicating the approach and progress of storms, I have investigated these reports for a period of nine months, viz., from October to December, 1864, and from October, 1867, to March, 1868, inclusive. Captain Toynbee, the Marine Superintendent of the Office, has also been engaged in the study of these Reports.

"The observations which are discussed have been all those which have been taken at our own stations within the limits of the British Islands, and, in addition, those from Brest, L'Orient, Rochefort, and the Helder. In 1864, the Helder was not a reporting station, and accordingly Heligoland was taken instead. All these stations, except the last named, are situated within the area of a circle 700 miles in diameter, whose centre is at Birmingham, Since the commencement of January, 1868, Reports have been received from Paris and Brussels, but these data have not been included in the present enquiry.

"The mode of investigation has been threefold:—

"I. To ascertain the greatest difference of pressure existing between any two stations within the area, at 8 a.m. on each day, with the resulting direction for the wind according to the law, and compare therewith the strong winds reported as having occurred at any stations during the twenty-four hours which succeeded the time of the observed barometrical difference.

"II. To extract the daily barometrical differences, and the resulting directions for the wind, along certain lines within the area, and compare therewith the winds recorded in the vicinity of those stations during the succeeding twenty-four hours.

"III. To extract each strong wind which was recorded at any station, and compare therewith the barometrical differences recorded along the lines in the vicinity of that station.

"By these three enquiries it has been sought to ascertain—

"What is the connexion between general barometrical disturbances and weather succeeding it.

"2. What accordance do the strong winds actually observed show with the directions over each district of the area as given by the law.

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* "Report of an Enquiry into the Connexion between Strong Winds and Barometrical Differences," by Robert H. Scott, M.A., F.R.S., Director of the Meteorological Office, 1869.

"3. What amount of indication was given of each strong wind by barometrical differences in its vicinity."

(31.) Without following out the discussion into the details of various periods within the dates above mentioned, Mr. Scott draws this conclusion from them :—

"It appears, then, as a final result, that if we notice on any morning a difference of 0.60 inches between any two stations, the chance is 7 to 3 that there will be a storm within the succeeding twenty-four hours. On the other hand, the chance is 9 to 1 that any storm which sets in will be preceded by unmistakeable signs of its approach, although the barometrical difference of readings may not amount to 0.60 inches at 8 a.m.

"Before leaving this branch of the enquiry, there is one result which seems of sufficient importance to deserve a special notice.

"I find that although there is a preponderance of instances in which the difference of six-tenths is followed by a gale, yet on several occasions the barometrical inequality exists after the violent motion of the air has come to an end.

"In ten instances during the whole nine months, I find that at 8 a.m. on the day after a serious gale there was a difference of, or exceeding, 0.6 inches, while there was not a gale during the remainder of the day. This seems to me to be a very remarkable result, and one well deserving of future investigation.

"It appears, also, from this table, that as regards direction the law receives strong confirmation.

"Southerly gales are preceded by a relatively low pressure in the West.

"Westerly gales are preceded by a relatively low pressure in the North.

"Northerly gales are preceded by a relatively low pressure in the East.

"Easterly gales are preceded by a relatively low pressure in the South.

"In devising a system for testing the law as applied to the different districts of the British Islands, and the North and West Coasts of France, we are met by various difficulties. The simplest statement of the law is that according to it the wind at any point will blow in the direction of a tangent, at that point, to the isobaric curve which represents the atmospherical conditions existing a short time previously.

"Firstly, the whole system of isobaric curves, or the whole distribution of atmospherical pressure, is known to be subject to a motion of translation over the earth's surface; but of this motion the direction and the rate vary, from day to day, to a considerable extent, and in a manner independent of each other. Neither of these points have been as yet satisfactorily investigated. Secondly, the wind, especially in storms, seldom blows for many hours consecutively from the same point, but either *veers* or *backs*, the former motion being much more usual than the latter.

"These considerations show us that we must not interpret the law too strictly, but must make some allowance for translation and for change of direction.

"The method which has been adopted for testing the winds on each day will be understood by reference to the adjoining plate, which is reduced from

the daily map for January 16, 17, 1868, showing the barometrical readings and the wind at the various stations at 8 a.m. on the 16th and 17th, with the gradients and their changes during the preceding twenty-four hours.

"It will be seen from these that the area has been, so to speak, triangulated, as well as the situations of the reporting stations will allow. By this means we have got a large number of lines of variable lengths, running in different directions. Perpendiculars are let fall on each of these lines, and the directions of the lines are taken according to the approximate compass bearings of these perpendiculars, which are the wind directions indicated, according to the law, by differences of barometrical readings at the extremities of the respective lines.

"In order to render the results obtained from lines of different lengths strictly comparable with each other, they have been reduced to one uniform standard of 100 miles. The actual length of each line, and the factor requisite to reduce its indications to those of the uniform standard length, and also the directions for the two winds indicated according as the barometrical reading at one end of the line is higher or lower than at the other, are here subjoined. These directions, of course, differ by 180°.

Bearing of Perpendicular.	Line.	Length in Miles.	Factor.	Indicated Wind.
W. 30° N.	Valencia to Greencastle -	236	$\frac{2}{5}$	E.S.E. or W.N.W.
W. 40° N.	Greencastle—Nairn - -	180	$\frac{5}{9}$	S.E. ,, N.W.
N. 30° W.	Greencastle—Leith - -	144	$\frac{5}{7}$	S.S.E. ,, N.N.W.
E. 10° N.	Leith—Nairn - - -	100	1	E. ,, W.
E.	Liverpool—Leith - - -	156	$\frac{5}{8}$	E. ,, W.
E. 40° N.	Liverpool—Greencastle -	189	$\frac{1}{2}$	N.E. ,, S.W.
N. 30° W.	Liverpool—Scarborough -	110	1	S.S.E. ,, N.N.W.
W. 40° S.	Scarborough—Leith - -	131	$\frac{3}{4}$	N.E. ,, S.W.
W. 40° S.	Helder—Nairn - - -	394	$\frac{1}{4}$	N.E. ,, S.W.
N. 30° E.	Heligoland—Nairn - -	445	$\frac{2}{9}$	N.N.E. ,, S.S.W.
S. 10° E.	Heligoland—Liverpool -	380	$\frac{1}{4}$	N. ,, S.
N. 10° E.	Helder—Liverpool - -	284	$\frac{1}{3}$	N. ,, S.
N. 30° W.	Heligoland—London - -	330	$\frac{3}{10}$	S.S.E. ,, N.N.W.
N. 30° W.	Helder—London - - -	200	$\frac{1}{5}$	S.S.E. ,, N.N.W.
W. 30° N.	Heligoland—Rochefort -	600	$\frac{1}{6}$	E.S.E. ,, W.N.W.
W. 30° N.	Helder—Rochefort - -	480	$\frac{1}{5}$	E.S.E. ,, W.N.W.
W. 10° S.	Weymouth—Liverpool -	172	$\frac{3}{5}$	E. ,, W.
W. 10° S.	Rochefort—Weymouth -	287	$\frac{1}{3}$	E. ,, W.
W. 10° S.	London—Scarborough - -	175	$\frac{4}{7}$	E. ,, W.
N. 20° W.	Penzance—London - -	220	$\frac{2}{3}$	S.S.E. ,, N.N.W.
N. 45° E.	Rochefort—Brest - - -	200	$\frac{2}{1}$	N.E. ,, S.W.
W. 20° S.	Brest—Penzance - - -	101	1	E.N.E. ,, W.S.W.
N. 45° E.	Brest—Valencia - - -	307	$\frac{1}{3}$	N.E. ,, S.W.
N. 45° E.	Penzance—Roche's Point -	138	$\frac{5}{7}$	N.E. ,, S.W.
N. 10° E.	Valencia—Roche's Point -	82	$\frac{5}{4}$	N. ,, S.
N. 20° W.	Valencia Liverpool - -	287	$\frac{1}{3}$	S.S.E. ,, N.N.W.

"These factors are, as will be seen, merely the nearest simple fractions to the proportions between the length of each line and the standard length.

Date.	Gradient.		Line.	Winds. Extreme.	Winds. Next Morning.
Jan. 16	S.S.E. 12	+25	Leith—Greencastle -	S.W. 9, Androssan. S.W. 8, Leith.	— —
	S.W. 21	+14	Liverpool-Greencastle	S. 9, Holyhead. S.W. 9, Androssan.	— —
	S.W. 12	− 4	Helder—Nairn - -	S.W. 8, Leith.	—
	S.W. 19	+ 3	Scarborough—Leith -	W. 8, Yarmouth.	—
	S.W. 25	+10	Penzance--Roche's Pt.	S. 12, Valencia. S.W. 9, Cape Clear.	— —
	W.S.W. 13	− 2	Brest—Penzance -	S.S.W. 8, Penzance. S.S.W. 9, Plymouth	— S.W. 9, Plymouth.
	W. 12	−16	Leith—Nairn - - -	S.W. 8, Leith.	—
	W. 16	− 4	Liverpool—Leith - -	S.W. 9, Androssan.	—
	W. 13	− 6	Weymouth-Liverpool	S.S.W. 8, Portsmth. S. 8, Weymouth. S. 9, Holyhead.	— S.W. 8, Portsmouth —
	W. 12	− 6	London—Scarborough	S.W. 9, London. W. 8, Yarmouth.	— —

Date.		Wind.		Station.	Preceding Gradient.		Line.
Jan. 16	Evening	S.	8	Holyhead -	S.W. 21	+14	Liverpool—Greencastle.
		S.	12	Valencia -	S.W. 25	+10	Penzance—Roche's Point
		S.S.W.	8	Penzance -			
		S.S.W.	9	Plymouth -			
		S.	8	Weymouth -	S.S.E. 5	+11	London—Penzance.
		S.S.W.	8	Portsmouth -			
		S.W.	8	Leith - -	S.S.E. 12	+25	Leith—Greencastle.
		S.W.	9	Ardrossan -			
		S.W.	9	Cape Clear -	S.W. 25	+10	Penzance—Roche's Point.
		S.W.	9	London - -	W. 12	− 6	London—Scarborough.
		W.	8	Yarmouth -			
17	Morning	S.W.	9	Plymouth -	W.S.W. 14	− 2	Brest—Penzance.
		S.W.	8	Portsmouth -			

"This shows us that the only gradient exceeding 0.12 on the 16th, which was not followed by a very decided fulfilment, was that of W. 13 from Weymouth to Liverpool. The predominating storms on the South coast of England were southerly, and had very little westing in them. They gave, however, abundant indications of their approach in the change of gradient of (+ 11) in the direction S.S.E. from London to Penzance.

"On the whole it will be seen that on the morning of the 16th there was a gale at only one station, viz., S. 10 at Valencia, and on the morning of the 17th there were only two, viz., S.W. 9 at Plymouth, and S.W. 8 at Portsmouth, while between these two dates gales were felt at 10 stations, which might reasonably have been foreseen by an examination of the morning reports of the 16th, on the principles laid down in the preceding pages."

(32.) What has been said previously as to the isobaric lines and barometric gradients, refer exclusively to the observations made and collected simultaneously on land. It is quite clear that this is inapplicable to the

condition of a ship on a voyage. Still something can be learned from the known phenomena of what is probable, and the reader is referred to a valuable paper in the "Mercantile Marine Magazine," 1872, by Mr. Birt, for many important practical hints, which are too long for quoting here, but a few extracts must suffice. They will relate to an examination of the Weather Charts, issued by the Meteorological Office, between March 15th and April 13th, 1872, the results of which are given in a tabular form.*

"In order to see the practical bearing of this table (not repeated here), it is necessary to recall the main feature of Buys-Ballot's law, viz., that the areas of high and low pressure are specially related to the direction of the wind. Taking the direction of the wind from East to West for example, and sailing or steaming with it, the area of high pressure is on the starboard or North, and that of low pressure on the port or left. The steepest gradient between Portsmouth and Dover during the thirty days is + .142, wind at Dover N., force 6. This gradient occurred on the 19th, but as no return for that day was received from Scilly, the barometric section from Scilly to Dover is not complete. The section for the previous day, the 18th, is complete, and shows a difference of about a quarter of an inch between the extreme stations. At all the stations the barometer was falling between 8 a.m. of the 18th and 8 a.m. of the 19th. Suppose we take a vessel on the 18th, having just passed the straits at 8 a.m. During her passage down channel her barometer *rose*, wind off Dover W.N.W., force 3, area of high pressure towards S.S.W. On consulting the weather charts, we find the isobars so arranged as to indicate the anterior slope of an atmospheric wave, stretching from S.S.W. or thereabout, towards Norway N.N.E.; the vessel was therefore sailing, or steaming towards the crest. In the case of a vessel steaming up channel on the 19th, she would have had a falling barometer with increasing wind force.

"On selecting the steepest gradient, dip towards the West (—), we find it to be — .071, wind S., force 3, at Dover, on March 27th, the wind increasing in force westward, being at Scilly 7, with a sea disturbance of 6, marked 'rough' on the map; area of highest pressure to the eastward; passage up channel, barometer rising, wind force decreasing; down channel, barometer falling, with wind force increasing. The weather chart for this day shows the isobars arranged as the posterior slope of a N.W. atmospheric wave. A vessel coming up channel approached the crest rather obliquely.

"It must especially be borne in mind that each vessel is entirely *isolated*, the commander having only the height of the barometer and direction of the wind at his ship, with Buys-Ballot's law, from which he is able to infer in what directions the high or low pressures exist, but whether he is approaching a crest or trough directly or obliquely, his data are inadequate to determine. We are not aware that sufficient has been effected at land stations to enable him to ascertain the general lay of the isobars from the rise or fall of the barometer at his ship, and here we see the value of discussing a large number of observations, in order to mark out with approximate precision the barometric affections of such a line as the South Coast of England. To

* See also "Weather Charts and Storm Warnings," by R. H. Scott, M.A., F.R.S. 1876.

effect this the labour is considerable, and it can only be accomplished on the large scale by an office charged not only with the work of collecting data, but of utilizing such data when obtained.

"In tabulating this, we have the whole line from Dover to Scilly divided into three portions, Dover to Portsmouth, Portsmouth to Plymouth, and Plymouth to Scilly. So far as the most important feature—the barometric gradients—is concerned, each portion differs, more or less, from its neighbours. Taking the gradients facing the East (+), we have on the line Portsmouth to Dover these gradients occurring on 20 days. On the line Plymouth to Portsmouth 12 days, and from Scilly to Plymouth 15 days. Of the reverse or facing the West (—), Dover to Portsmouth 7 days, Portsmouth to Plymouth 13 days, and Plymouth to Scilly 12 days. On three occasions the barometer was equal in height at Dover and Portsmouth, on five at Portsmouth and Plymouth, and two at Plymouth and Scilly. These results clearly show that the barometric movements are very complex; nevertheless, it is possible that each portion of the channel may have its specific type.

"A graphical representation is conclusive as to the connection between barometric differences or gradients, wind force, and sea disturbance. A determination of the law of this connection is important. We can, however, look at this matter in another light; for instance, we can take the mean wind force and sea disturbance for each station as under:—

Dover . .	2.7 Wind.	2.0 Sea.	Plymouth .	2.4 Wind.	1.5 Sea.
Portsmouth	3.5 ,,	3.0 ,,	Scilly . .	4.7 ,,	4.4 ,,

"These numbers show that, with the exception of Plymouth, both wind force and sea disturbance increases as we proceed westward. Bearing in mind that the scale of wind force is 0—12, and that of sea disturbance 0—9, the increase of sea disturbance is greater in proportion at Scilly than within the channel.

"We have already alluded to the *isolated* condition of each vessel as she sails or steams up or down channel; and from the above example of discussing the daily readings, it appears that in the passage down channel a commander, on the average, meets with increasing force of wind, increasing sea disturbance, and increasing barometric gradients. An important question here arises; How is a commander to ascertain his gradient in his *isolated* position? On passing the Straits, his barometer stands at a certain height, on passing Portsmouth it has risen, but the difference will not give him his gradient, for he is ignorant of the height of the mercury at Dover when he is off Portsmouth. The rise he records is compounded of two quantities, that due to the gradient he has sailed through plus (+) the absolute rise of the barometer at the two stations during his voyage from one to the other; or it may be that the portion due to the gradient is *reduced* by a fall of the barometer during the interval; for example, the gradient on March 19th, between Portsmouth and Dover, was + .142. On the 18th the barometer stood at 30.01 at Portsmouth, on the 19th it was 29 94, fall in the 24 hours 0.07. On the 18th, at Dover, the barometer read 29.87, on the 19th 29.78, fall in the 24 hours 0.09. The barometric difference between the stations on

the 18th was .14, on the 19th .16. If, then, the barometer at the ship, on the 18th, off Dover, read 29.87, and off Portsmouth on the 19th, 24 hours afterwards, 29.94, the captain would record a *rise* of 0.07, the barometer having really *fallen* 0.08 at a point intermediate between the stations: thus, while a *real* gradient of + .142 existed between Dover and Portsmouth on the 19th, *the barometer having fallen at both stations during the previous* 24 *hours*, a captain sailing from Dover to Portsmouth during the same 24 hours would record an *apparent* gradient of + .062, the *reduction* from the *real* gradient arising from the *fall* of the barometer at *both* stations, while the *rise* of his barometer resulted from his sailing toward the region of higher pressure."

3.—THE TRADE WIND.

(33.) The region of the trade wind occupies nearly one-half of the entire surface of the globe. From their constancy and regularity they form by far the most important part of the circulatory system of the atmosphere, although generally their strength is inferior to many of those smaller but compensating currents which are experienced in ex-tropical regions.

(34.) The source from which the ensuing *statistics* of the various winds described is the extensive collection of observations recorded in the *Pilot Charts* of Lieutenant M. F. Maury, U.S.N., published in 1849. On our Chart of the North Atlantic Ocean, in four sheets, to which this work especially refers, these wind records are also arranged in a simple and comprehensive graphic form. In the year 1876 there was issued by the Meteorological Office an analysis of the meteorology of the equatorial region of the Atlantic, between lat. 20° N. and 10° S., and long. 10° to 40° W. This elaborate work, produced by Capt. Toynbee, F.R.A.S., F.R.G.S., is chiefly derived from data collected by the late Admiral FitzRoy, and may be said to supersede the above mentioned work of Captain Maury, or that part of it which relates to the crossing of the equator. We give on page 203, *et seq.*, Capt. Toynbee's remarks on the winds observed in this region.

(35.) The **North-East Trade Wind** blows over the tropical region between lat. 36° North and the Equator, seldom, however, reaching these extremes. When uninterrupted by gales or hurricanes, caused by the disturbing influences of land or rain, it is a fair weather region that procured for it the term of "The Lady's Gulf," by the old Spaniards. From the difference 0.055 inches in the observed mean barometric pressure by the Dutch in the N.E. and S.E. trades, between the parallels of 5° and 20°, which is 29.968 inches for the former, and 30.023 inches for the latter, it is inferred by Captain Maury that the greater pressure in the S.E. trades indicates a greater force and velocity* than the N.E. trades. This, as investigated by Commander Maury, has been indicated by the rate of vessels daily passing through them. He has compared the sailings of 2,235 vessels, and finds

* It is generally argued, that less barometric pressure indicates increased force of wind, and not the reverse, as it is here argued; but from the following note it will be seen that these pressures are more nearly alike than is stated above.

that the homeward bound vessels cross the trades of the North Atlantic with the wind abeam at an average rate of 5.6 knots per hour, and across the trades of the South Atlantic at an average rate of 6 knots. As the latter is with the wind generally dead aft, he argues that this rate would be increased 2 or $2\frac{1}{2}$ knots with the wind on the beam, and make the difference still more evident. The comparative duration of each of these winds in the Atlantic is thus given by Captain Maury:—

Between Latitudes.	N.E. Trades.		S.E. Trades.	
	Mean Direction.	Annual Direction.	Mean Direction.	Annual Duration.
° °	°		°	
0 and 5	N. 48 E.	76 days.	E. 34 S.	38 days.
5 10	N. 46 E.	118 „	E. 41 S.	329 „
10 15	N. 47 E.	208 „	E. 37 S.	305 „
15 20	N. 46 E.	197 „	E. 34 S.	253 „
20 25	N. 43 E.	167 „	E. 34 S.	163 „
Means.	N. 46 E.	153 days.	E. 36 S.	272 days.*

(36.) The force of the wind is an important element in these calculations, and Captain Maury's system has been enlarged upon by Lieutenant J. C. de Brito, of the Portuguese Royal Navy, who has investigated the rates of sailing of 1,548 tracks across the Atlantic, and has arrived at some important and unexpected results, differing in some degree from the conclusions of the great American meteorologist.

Lieutenant de Brito reduced the courses of all his ships to the most favourable point of sailing for all ships, that is, with the wind *free*, and has taken the months of February and March for one season, and those of August and September for the opposite. His enquiries relate to both trade winds—the S.E. as well as the N.E.

(37.) For the N.E. trade he has 803 tracks—424 Dutch, and 379 American. The region of this trade he divides into *four* parts, viz.:—1. The *eastern*, or that frequented by ships going South and passing to the *eastward* of the Cape Verde Islands. 2. The mean route of vessels going South and passing *westward* of those islands. 3. The *central* part, containing the routes to the southward of ships from Europe and America. 4. The part containing the *westernmost homeward routes* of American vessels.

* As this table is founded on the assumption that the Equator is the division between the two wind systems, instead of the parallels of 5° to 9° N., as is really the case, it cannot be taken as a fair comparison of their relative duration. If the parallel of 5° N. be taken as a division, the mean barometric pressure in the N. E. trades is 30.057 inches, and in the S.E. trades 30.034 inches, making the latter the least. If the winds recorded between 0° and 5° N. be added to the S.E. trades, it will give a mean duration of 239 days, and make the N.E. trades 172 days.

For February and March, he finds that—

1. *East* of the Cape Verdes, the mean rate of 20 vessels, from 30° N. to 5° N., is 6.1 miles.
2. *West* of the Cape Verdes, the mean rate of 71 vessels, from 30° N. to 5° N., is 6.3 miles.
3. For the *Central* part, the mean rate of 262 vessels, from 25° N. to 5° N., is 6.5 miles.
4. For the *Westernmost* route, 44 American ships sailing from the Equator to 25° N., between long. 32° and 33° W., give a mean rate of 6.7 miles.

Hence, for the whole region of the N.E. trade, during February and March, the mean rate is 6.4 miles.

For August and September, when the N.E. trade is weakest, and is in its most northern position—

1. *East* of the Cape Verdes, the mean rate of 18 vessels, from 30° N. to 15° N , is about 6.3 miles.
2. *West* of the Cape Verdes, the mean rate of 155 vessels, from 30° N. to 15° N., is 6.5 miles.
3. For the *Central* part, the mean rate of 198 vessels, from 30° N. to 15° N., is 5.3 miles.
4. On the *Westernmost* route, 35 American homeward bound vessels, from 10° N. to 30° N., give a mean rate of 4.8 miles.

And for the whole region of the N.E. trade, during August and September, the mean rate is 5.7 miles.

For the strength of the S.E. trade, there are 655 tracks—417 Dutch, and 238 American; and the regions are:—1. The *western*, in which the vessels go southwards. 2. The *central*, in which the ships are coming from the East Indies.

During August and September, it appears that—

1. For the *Western* route, 232 vessels gave a mean rate of 7.5 miles.
2. For the *Central* route, 124 vessels gave a mean rate of 7.4 miles.

During February and March, the results are as follows—

1. For the *Western* route, 142 vessels give 7.0 miles.
2. For the *Central* route, 157 vessels give 7.1 miles.

(38.) The S.W. monsoon region gives, according to 90 Portuguese ships, an average rate of 4.9 miles for February and March; and 5.3 miles for August and September.

From these observations it appears that the N.E. trade undergoes, in the two epochs, considerable change of strength, viz., equal to 0.7 mile in favour of the February and March period; on the other hand, the S.E. trade is stronger by 0.4 mile in the August and September period than during that for February and March.

Comparing the two trades (N.E. and S.E.) together, it would seem that the S.E. is 1.2. miles stronger than the N.E.

Again, ships bound to the southward may generally expect to find the N.E. trade stronger on the *Central* route, during February and March, than more to the eastward; while in the August and September epoch, they will find this wind blowing with its greatest intensity between the meridians of 20° and 25° W.

This last observation deserves consideration, because it is generally believed that the wind is stronger in proportion as the distance from the African shore is increased.

(39.) The N.E., like the S.E., trade wind, blows over a wider area in the eastern part of the Atlantic than on the American side, as at the meridian of 10° W. they extend from 35° or 38° N. to 25° or 28° S.; while on the American side the North limit is 28° or 30° N. to 23° or 25° S.; but on the eastern side the intervening space of calms is much wider. The extent and limits will be best comprehended by an inspection of the diagrams adjoining, which are formed from the tabular statements drawn up by Commander Maury and by the Dutch Meteorological Institute, and for the equatorial region by Captain Toynbee. They will explain better the various lines and fluctuations than would be done by a long series of words.

The *northern limit* of the N.E. trade wind, as will be seen, extends on the eastern side of the Atlantic, that is off the coast of Africa, to lat. 35° as a mean, in August and September, being then at its greatest northern extent; but it is frequently encountered when in lat. 38°, or sometimes even at 40°. To the westward of the meridian of 30° the northern edge seldom extends northward of 33° or 34°, while toward the Bahamas the northern limit is 30° N. This extreme northern declination appears to be attained in August and September, as has been said before, when following the sun in its south ward course it reaches its southern limits in March or April. In January its mean limit on the eastern side is about the Canaries; over the eastern half of the Atlantic in about 25° N.; in the centre about 22° N.; and on the Bahamas it seldom vibrates to any great extent throughout the year.

The extent of variation between the northern edge of the trade winds when first encountered, as shown by Maury's Trade Wind Charts, seems to be as much as 10 degrees of latitude—a wide range of probability—and in many cases there appears from these charts to be as much chance of meeting them in one latitude as another. Of course this is taking into account the belt of calms and variable winds usually (but not always) found on the edge of the trades, which will be spoken of presently.

(40.) The *southern edge of the N.E. trade wind* is limited in the eastern part by that broad region so embarrassing to the sailor, known as the "doldrums," or especially during the northern summer months by a set of winds blowing towards the coast of Africa, known of old as the West African S.W. monsoon. This wedge-shaped area, whose apex reaches in July to 40° or 45° W., extends on the African coast at that period from 5° N. to 16° or 17° N. To the West of this there is still a belt of almost constant rain "under the equatorial cloud ring, which, however, is much narrower, and perhaps at times may not be encountered, called the Equatorial calms. The trade wind is at its southerly limit in March and April, reaching in mid-ocean some-

times to 3° S., but seldom so far as 3° N. on the East side. It remains there for two or three months, and then advances northward till August and September, when it is seldom found South of the parallel of 9° N.; indeed, this parallel may be taken as the mean limit of the N.E. trades. This northern division of the trade wind is owing to the unequal distribution of land in the two hemispheres.

The following useful Table is that drawn up by the late Capt. Horsburgh, as the limits usually found in the track generally pursued by the East Indiamen, at the commencement of the present century:—

TABLE, *showing the Equinoctial Limits of the N.E. and S.E. Trade Winds, between the Meridians of* 18 *and* 26 *degrees West.*

	N.E. TRADE WIND.		S.E. TRADE WIND.		INTERVAL BETWEEN.
CEASES.	General Extremes.	Probable Mean.	General Extremes.	Probable Mean.	Mean Breadth.
	° °	°	° °	°	
In January at	3 to 10 N.	5 N.	$0\frac{1}{2}$ to 4 N.	$2\frac{3}{4}$ N.	$2\frac{1}{4}$ degrees.
February	2 to 10 —	4 —	$0\frac{1}{2}$ to 3 —	$1\frac{1}{4}$ —	$3\frac{1}{3}$ „
March	2 to 8 —	$4\frac{3}{4}$ —	$0\frac{1}{2}$ to $2\frac{1}{2}$ —	$1\frac{1}{4}$ —	$3\frac{1}{2}$ „
April	$2\frac{1}{2}$ to 9 —	5 —	0 to $2\frac{1}{2}$ —	$1\frac{1}{4}$ —	$3\frac{3}{4}$ „
May	4 to 10 —	$6\frac{1}{2}$ —	0 to 4 —	$3\frac{1}{2}$ —	4 „
June	$6\frac{1}{2}$ to 13 —	$8\frac{1}{2}$ —	0 to 5 —	3 —	$5\frac{1}{2}$ „
July	$8\frac{1}{2}$ to 14 —	11 —	1 to 6 —	$3\frac{1}{2}$ —	$7\frac{1}{2}$ „
August	11 to 15 —	13 —	1 to 5 —	$3\frac{1}{4}$ —	$9\frac{3}{4}$ „
September.....	9 to 14 —	$11\frac{1}{2}$ —	1 to 5 —	3 —	$8\frac{1}{2}$ „
October	$7\frac{1}{2}$ to 14 —	10 —	1 to 5 —	3 —	7 „
November	6 to 11 —	8 —	1 to 5 —	3 —	$4\frac{1}{4}$ „
December	3 to 7 —	$5\frac{1}{2}$ —	1 to $4\frac{1}{2}$ —	$3\frac{1}{2}$ —	$2\frac{1}{4}$ „

(41.) The *direction of the N.E. trade wind* is an important nautical consideration. Its mean direction in the circuit of the earth is estimated at N. 47° E., but it varies considerably under the influence of the land, and especially so in the North Atlantic. As mentioned above, the trade wind blows much more from the northward to the eastward of long. 25°—that is, within 400 or 500 miles of the African coast than it does in the open ocean. Between the Canaries and Cape Verde, during the northern summer months, it blows from N.N.E. and N.E. for 55 days out of every 100.

During the winter months, from January to March, the wind in the neighbourhood of Cape Verde draws very much toward the land, or from N.W. and W. This point will be more discussed in a later part of this work.

(42.) In order more fully to exemplify the duration and direction of the trade wind, the adjoining diagrams have been selected from the Chart of the North Atlantic Ocean. They will show the particulars of the wind between the parallels of 10° and 20° N.; that is, in the main strength of the N.E. trades. They have been adapted from Maury's Pilot Charts, as appeared before (34) and will show the per centage of winds from any quarter in each of the four *calendar* seasons; and also the amount per cent. of calms encountered. The plate will explain the different arrows (indicating the

seasons) which are supposed to represent winds blowing *toward* the centre of the circle, because the winds take their names from the quarters *from* whence they come, the *North* point being supposed to be at the top of the page, the South at the bottom, the East to the right, and the West to the left hand. The *length* of the uppermost arrows is proportioned to the duration or frequency of that wind, according to the scale attached; so that by applying the compasses to any one of the arrows, it will give, according to the scale, the amount of wind *per cent.* for that direction. These arrows are given for sixteen points of the compass, omitting the "by" points, in each season. The arrows altogether make up the length of 3 inches, that of the scale given.* In the centre of each diagram is given the smount per cent. of *calms* encountered in the respeetive seasons. As the *force* of the winds is not given in the Pilot Charts, this register of the calms is the more important, as it is the only scale we can apply to the force of this wind; as, by analogy, we may argue, that were calms predominate, there also do light and baffling winds, and the reverse.

(43.) An analysis of the wind-roses in Captain Maury's Chart, from which these diagrams are constructed, will give the following figures as the prevalence and direction of the winds along the main strength of the N.E. trades in the North Atlantic. It must be premised, however, that these figures, as well as the data from which they are derived, will give only a general view of the phenomena likely to be encountered, and the *chances* per cent. that a ship will have of meeting with similar winds or calms. The figures in these colums give the number of days (or observations) the wind blow, in *each hundred*, from the respective directions:—

Fig. 1.—*In the neighbourhood of the Cape Verde Islands.*

	Between N. & E.	E. & S.	S. & W.	W. & N.	Mean.	Frequent.	Calms.
Winter	73	12	10	7	N.E.	E.N.E.	1.1
Spring	76	18	4	2	N.E.	N.E.. N.N.E.	1.8
Summer	70	14	4	12	N.N.E.	N.N.E.	8.5
Autumn	63	22	6	9	N.E.	E.N.E.	4.7

* There is one remark which it is necessary to make here respecting these wind observations (220,000 in number). They have been taken from a vast quantity of different log-books, whose remarks are not made with the definite accuracy necessary for scientific precision. A slight inspection of the figures given on the diagram, or of the Board of Trade charts, will show that in these data the direction of the wind is loosely and indefinitely given throughout. Thus, a wind between N. and E. is set down as a N.E. wind, &c., &c., and not so often as as a N.N.E. or E.N.E. as must really occur. Consequently, the arrows representing these principal or cardinal points are longer than they ought to be, and the intermediate ones shorter; in fact, they form a zig-zag or irregular curve around the centre; whereas it is manifest that this curve should be somewhat symmetrical, and that the wind blows from the intermediate points in some regular ratio to those on either side of it. Until we get more exact records added together in great numbers, as has been done in the Pilot Charts with these imperfect logs, it is plainly futile to draw any precise or refined conclusions from their teaching. This is not said to underrate their value. To the sailor, who only requires a general exact knowledge of the subject, they teach as much almost as he requires to know as to the direction of the wind.

NORTH

Diagrams illustrating the direction of

THE N.E. TRADE WIND,

between Latitudes 10° & 20° N.

WEST

EAST

FIG. 1.
about the Cape Verde Is.

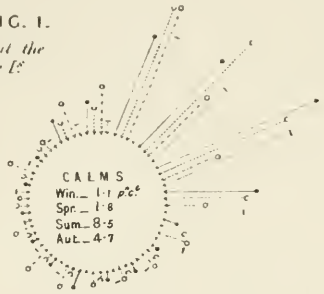

FIG. 2.
Lon. 20°–40° W.

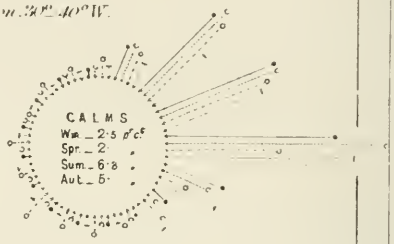

FIG. 3.
Lon. 40°–50° W.

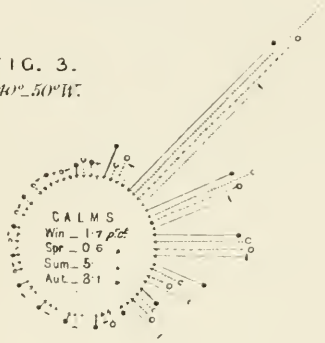

FIG. 4.
Lon. 50°–60° W.

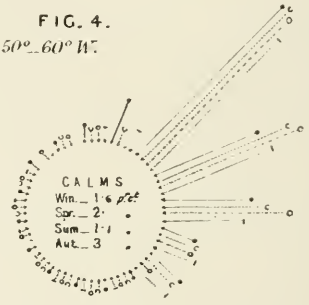

FIG. 5.
about the Windward Is.

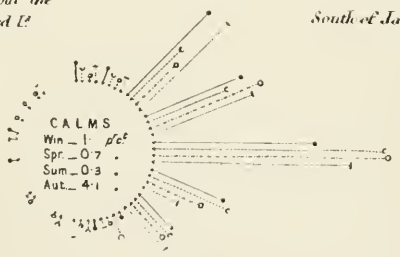

FIG. 6.
South of Jamaica

The arrows represent winds *blowing toward the centre*

Winter (Jan. Feb. Mar.) Spring (Apr. May June) Summer (July Aug. Sep.) Autumn (Oct. Nov. Dec.)

The length of the arrows is proportionate to the frequency of that wind, and the proportion per cent will be given by this scale.

5 10 20 30 40 50 60 70 80 90 100

SOUTH

R.H. [illegible], London

Fig. 2.—*Between Lats.* 10° *and* 20° *N. and Longs.* 30° *and* 40° *W.*

	Between N. & E.	E. & S.	S. & W.	W. & N.	Mean.	Frequent.	Calms.
Winter	45	41	2	2	E. by N. $\frac{1}{2}$ N.	East.	2.5
Spring	48	48	2	2	E.N.E.	East.	2.
Summer	48	32	12	2	E.N E.	N.E. to E.	6.3
Autumn	32	51	9	2	E. by N.	East.	5.

Fig. 3.—*Between Lats.* 10° *and* 20° *N. and Longs.* 40° *and* 50° *W.*

Winter	60	26	8	6	N.E. $\frac{1}{2}$ E.	N.E.	1.7
Spring	70	25	0	5	N.E. by E.	N.E.	0.6
Summer	63	29	4	4	N.E. by E. $\frac{3}{4}$ E.	N.E.	5.
Autumn	50	34	4	2	N.E. $\frac{1}{4}$ E.	N.E.	3.1

Fig. 4.—*Between Lats.* 10° *and* 20° *N. and Longs.* 50° *and* 60° *W.*

Winter	66	33	7	5	N.E. by E.	N.E.	1.6
Spring	65	30	2	3	N.E. by E. $\frac{1}{2}$ E.	N.E.	2.
Summer	63	31	4	2	E.N.E.	N.E., E.N.E.	1.1
Autumn	59	29	2	0	N.E. by E. $\frac{3}{4}$ E.	N.E.	3.

Fig. 5.—*In the East Part of the Caribbean Sea, near the Windward Isles.*

Winter	42	46	0	2	E. by N. $\frac{1}{2}$ N.	East.	1.
Spring	35	63	2	0	E. $\frac{1}{2}$ N.	East.	0.7
Summer	33	61	3	3	East.	East.	0.3
Autumn	44	51	2	3	E. by N.	East.	4.1

Fig. 6.—*In the West part of the Caribbean Sea, South of Jamaica, &c.*

Winter	47	42	6	5	E. by N.	N.E., E.	6.7
Spring	42	50	8	0	E. by N.	East.	2.9
Summer	44	56	0	0	E.N.E.	East.	10.
Autumn	54	43	3	0	E.N.E.	N.E., E.	9.6

(44.) In examining the figures in these tables, and the illustrative diagrams, it will be seen by Fig. 1, that the wind about the Cape Verde Islands, or that part of the Atlantic most frequently crossed by vessels from Europe, that the mean direction of the trade wind is to the northward of N.E.; and further, that calms and light airs are more prevalent than further to the westward, especially in the summer and autumn months, July to December, in the former season. It has always been held that the wind draws more to the eastward as you get to the westward of the usual crossing of the Equator, and this an inspection of Fig. 2 will verify, when it is seen that

the mean direction is South of E.N.E., and that the calms, taking the years round, are less frequent.

Whether the Cape Verde Archipelago has an influence in thus causing the trade wind to assume a more easterly direction to the westward cannot very well be determined; but it is certain that this E.N.E. direction is not maintained between longitude 40° and the West Indies, as Figs. 3 and 4 show that winds hold persistently to the N.E., or a little to the South of it, although winds to the northward of N.E. are very rare. It is probable, also, that the winds recorded from the other directions are exceptional.

The easterly direction of the trade wind in the Caribbean Sea will be readily noticed. It will be further remarked on in the observations on the winds of the West Indies hereafter.

(45.) The calendar seasons of northern latitudes are here taken as the quarters of the year. In the American charts these seasons are made to include the month before the usual reckoning; thus, winter begins with December; spring, with March, &c. Perhaps the latter mode of division would be rather more applicable to the tropical phenomena than that here chosen, because it appears that the changes in the inter-tropical seasons (to which, however, the terms winter, spring, &c., are not applicable) seem rather to coincide with the American calculation. But as these changes are certainly not simultaneous in the northern latitudes, and, as including such a difference would involve some confusion, the ordinary terms used to designate European seasons is here adhered to as being readily comprehended and sufficiently exact.

(46.) The following summary of trade winds was given by Commander Maury in connection with his "Wind and Current Chart:"—

"There is a marked difference in the prevailing direction of the wind, not only according to the season of the year, but also according to different parts of the ocean, including even those parts which are between the same parallels of latitude, but in different longitudes.

"As a general rule it may be remarked:—

"1st. That in the North Atlantic the nearer to the coast of Africa and the Equator, the more the so-called N.E. trade winds haul to the South.

"2nd. That to the West of long. 45°, between 20° and 30° N., the N.E. trades blow much more steadily in May, June, July, and September, than they do the rest of the year; and that during the other months, particularly in March, they blow between these parallels nearly alike from all points of the compass.

"3rd. That between lat. 15° and 20° N. they are most variable; West of long. 35°, in the months of September, October, and November; while to the East of 30°, between the parallels, they are most variable in February, March, April, and October.

"4th. That between lat. 10° and 15° to the West of 35°, they are steadily between E.N.E. and S.E., except in July, August, September, October, and November, when they are more variable, being most variable in the three months first named. To the East of 35° W., between these parallels, they may be said to lose their trade character during the months of July, August, September, and October particularly in August and September, when they

blow nearly alike from the four quarters. Calms, too, are more frequent here in these months.

"5th. That between the Equator and 10° N., to the East of long. 30°, the winds assume a new feature. It may be said, almost literally, that in this part of the ocean they uniformly blow, when they blow at all, during the months of July, August, and September, from some point between S.E. and W. They blow most between S. and W.S.W., and very rarely from any point between N. and E.S.E. To the West of this meridian, during the same months, they blow most between S.E. and N.E., inclining more and more to the North as you go West. These are the months in which the winds vary in this part of the ocean."

(47.) The following are Capt. Toynbee's remarks which accompany monthly charts* of the prevailing winds in the region of the Atlantic, between lat. 20° N. and 10° S., and long. 10° to 40° W. In the chapter of this work devoted to Passages, some illustrations will be found, together with Captain Toynbee's remarks on the best route across the equator.

January.—The N.E. trade has advanced about 2° to the southward on the western side of the district since December, where it now prevails to the Equator; but on the eastern side it holds much the same position as in December. On the eastern side it falls lighter and draws more northerly than it does further to the westward, while near to the African land it becomes very light and north-westerly. It has decidedly increased in force since December. In square 40 it is very squally and gusty, much more so than in the squares to the eastward, which is the more remarkable as square 40 is open sea, whilst square 39 contains the Cape Verde Islands. Perhaps the proximity of square 40 to the area of high pressure may have something to do with it, as the gusts often come with a clear sky and with very little wind between them, as though they were the effect of downward rushes of dry air. Sharp gusts with blue sky, very cool weather, and the atmosphere very transparent, are often experienced at the polar verge of each trade.

The S.E. trade prevails to 4° N. in the central part of the district, and there is a prevailing southerly wind up to 8° N. on its extreme eastern side; but it is very light, and the weather very unsettled. Near the Equator the S.E. trade has very decidedly decreased in force since December.

February.—The N.E. trade has advanced nearly 2° to the southward since January; it now extends to about 4° N. on the eastern side, and to the Equator on the western side of the district. It still falls light and becomes north-westerly near the African land. Between 10° and 20° N. it has decidedly decreased in force since January, whilst between 0° and 10° N. its force has increased. It is still very gusty in square 40, and in some cases the gusts are strongest when the sky is clear, and are called "hard clear squalls."

The S.E. trade prevails to 9° N. in the central part of the district, whilst on the eastern side a light south-westerly wind prevails between 4° and 6°N., where it is met by the light north-westerly wind of the N.E. trade. The S.E.

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* Meteorological data for the nine 10° squares of the Atlantic, which lie between lat 20° N. and 10° S., and extend from long. 10° to 40° W

trade has decidedly decreased in force since January. In square 302 there is frequent mention of squalls or sudden shifts of wind from S.E. to N.E., as though the upper current of air sometimes forced itself to the surface.

March.—The N.E. trade holds much the same position in the central part and on the eastern side of the district as in February, but it has advanced to the southward of the Equator near South America. Its direction has become more north-westerly on the eastern side of the district than it was in February, where it also continues to be much lighter than on the western side. It has decreased in force since February. Square 40 is still remarkable for having strong gusts of wind, and in some cases it is recorded that they are stronger with a clear than with a cloudy sky.

The S.E. trade still prevails to 2° N. in the central and eastern part of the district, and a south-westerly wind is found to prevail as far as 8° N. between 15° and 20° W., where it meets the prevailing north-westerly wind of the N.E. trade, both blowing towards the area of lowest pressure. It seems to have slightly increased in force since February.

April.—The direction of the N.E. trade is very similar to that for March, it being still north-easterly on the western side of the district, northerly between 20° and 25° W., and drawing into a light north-westerly wind on its eastern side, where it extends 2° more to the southward than in March. Between 18° and 20° N. there has been but little change since March, but to the southward of that latitude it has decidedly decreased. Gusts of wind are rarely reported in square 40, but puffs (a weaker kind of gust) were still very common, and much more frequent than in square 39.

The S.E. trade only prevails to 4° S. on the western side of the district, but it extends to 4° N. on its eastern side.

The prevailing south-easterly wind shown between 8° and 10° N. on the eastern side of the district is the result of only one observation, whilst the north-westerly winds which surround it number thirty, so that north-westerly winds may be supposed to prevail there. The S.E. trade has decreased in force since March.

May.—The direction of the N.E. trade is very similar to that of April, though rather more easterly between 20° and 25° W.; its force has increased in the northern part of the district, but decidedly decreased to the southward of 10° N. It has generally receded fully 2° before the S.E. trade, but on the eastern side it has given way 4°. The N.E. trade is still much more gusty in square 40 than in 39, and the gusts are sometimes heavy with clear weather. Gusts and puffs are also common in the northern part of square 4.

The S.E. trade prevails to the Equator on the western side, and a southerly wind to 8° N. on the eastern side of the district; besides gaining so much on the N.E., the S.E. trade has decidedly increased in force since April.

June.—The direction of the N.E. trade continues very similar to what it was in May, drawing into a north-westerly wind near the coast of Africa. Its force has decidedly increased between 16° and 20° N., but decreased to the southward of 16° N. It has generally receded 2°, and in some parts of the district 4° to the North. It is still much more gusty and puffy in square 40 than in square 39.

The S.E. trade prevails to 6° N. except on the extreme western side of the

district; on its eastern side south-westerly winds prevail to 8° N., and even to 10° N., between 15° and 20° W. The S.E. trade has very decidedly increased in strength since May.

July.—The N.E. trade still draws more northerly and eventually north-westerly as it approaches Africa; its force has very decidedly decreased since June, and it has receded nearly 4° before the southerly wind. In square 40 it is very much more gusty than in square 39, so much so that although square 39 had nearly four times as many wind observations as square 40, the number of gusts and puffs there is not nearly so great.

The S.E. trade now prevails to 10° N., and there is a prevailing S.S.W. wind up to 12° N. on the eastern side of the district; between 12° and 14° N. on the same side the prevailing wind is West, and to the northward of that latitude north-westerly. Having frequently passed from the northward between the Cape Verde Islands and Africa in July, I can well remember the wind going from N.W. to W. and S.W. as we sailed to the southward. The July diagram gives a picture of the winds then sailed through. The S.E. trade has increased in force since June, especially the southerly winds to the North of the Equator.

August.—The N.E. trade is still lighter, more northerly, and in some cases north-westerly near Africa. Its force has decreased since July, and it has receded about 2° to the northward, its southern limit being now at its northern verge for the year.

The prevailing southerly wind now extends to 14° N. on the eastern side of the district. On the northern side of the Equator its force has very decidedly increased since July, but it has not changed much in the South. The S.E. trade is more southerly in square 303 (near South America) as well as being more squally and unsteady than in the squares to the eastward of it.

September.—The N.E. trade has increased in force, but is blowing in the same part of the district as in August.

The southerly winds North of the Equator continue to blow over the same part of the sea as in August; they also continue to draw into south-westerly winds as they approach the area of lowest pressure near the West Coast of Africa; their force has very decidedly decreased since August. To the southward of the Equator the S.E. trade has decidedly increased in force since August. The gradient for north-easterly winds seems to be steeper than for south-easterly of the same force; this appears to be common in other months also, and probably indicates that the N.E. trade gradient gets some of its supply of air from a downward movement, whilst that part of the S.E. trade with which we are dealing is probably more entirely a horizontal motion of air. The dry, transparent, gusty nature of the northern part of the N.E. trade probably points to the same fact.

October.—The N.E. trade has advanced several degrees to the southward, especially on the eastern side of the district, and now prevails to 8° N.; by this change it has extended over that part of the sea where there is the highest temperature of both air and sea, so that instead of north-westerly and south-westerly winds blowing into the area of highest temperature, there is a N.E. wind blowing from it! The N.E. trade has increased in force since September.

The S.E. trade prevails to 8° N., and there is no prevailing south-westerly wind, it having given way to the N.E. trade. The S.E. trade has very much decreased in force since September, especially in the southern part of the district.

November.—The N.E. trade has advanced about 2° to the southward since October, and now prevails to 6° N.; it still extends over the hottest area of air and sea, and, as in October, has not that tendency to draw into a north-westerly wind near the Coast of Africa which it had in previous months. In the most northern part of the district it does become more northerly near Africa, but in about 10° N. it becomes more easterly again, and draws away from the land. The N.E. trade has generally increased in force since October, but the increase is chiefly near its southern limits, in the extreme North of the district its force has decreased, where also the percentages of south-easterly and south-westerly winds have much increased since October, which seems to show that the northern limit of the trade is not very far North of the district in November.

The S E. trade prevails to 6° N.; South of the Equator it has increased in force since October, but decreased to the northward of it.

December.—The N.E. trade has advanced 2° to the southward since November, and now prevails to 4° N. Near the African land the wind again becomes light, and more northerly, changing even to north-westerly between 6° and 10° N., but the prevailing wind still blows north-easterly, *from* the hottest air and sea. The most remarkable feature in the direction of the N.E. trade in December is its prevalence at East between 10° and 20° N. and 25° to 30° W.; between 18° and 20° 40 per cent. of the wind observations are from East, or some point to the southward of East. It seems most probable that this remarkable difference in the direction of the wind is caused by the Cape Verde Islands, though it is difficult to say why they should not have a similar effect in some other month. The N.E. trade has decidedly increased in force since November. Considering the number of wind observations in each square, the percentage of gusty and puffy winds is much greater in square 40 than in square 39. Between 16° and 17° N. and 34° and 36° W. there were heavy squalls without either clouds or rain. Fine weather winds, and squally winds having a force 7 or upwards, are more common in square 40 than in 39.

The S.E. trade prevails to 4° N. · It has very decidedly decreased in force since November.

Conclusion.—The N.E. trade sometimes seems to draw round the Coast of Africa in the same way that water does round a rock, whilst the current arrows show that the sea has a similar motion. The trade gets weakest in that part of the sea where the difference of temperature of both air and sea is greatest, which is contrary to the theory of some meteorologists. Sometimes it seems to blow from hot towards cooler air, as shown in the diagrams of October and November. The remarkable clear-weather gusts experienced in square 40 have been remarked upon in the course of the paper as probably downward rushes of air.

The "Remarks on Wind" show that both the N.E. and S.E. trades are often more easterly and weaker in force during the night than during the day.

Attention has been called to the fact that in December the N.E. trade is diverted into an East wind on the western side of the Cape Verde Islands, whilst to the eastward of them it blows from N.N.E. It has also been shown that during the southern winter the wind and weather near Cape St. Roque are much more unsettled than they are in parts of the sea in the same latitude, but further East.

It should be clearly understood that whilst the diagrams only show the wind from that point of the compass which has the largest number of observations, a great variety of other winds blow in those parts where the two trades meet, especially in the atmospherical eddy which curves round the south-western part of North Africa; into it the northern verge of the S.E. trade is drawn as a light south-westerly wind, where it meets the southern verge of the N.E. trade as a N.W. wind, and the result of their meeting is the greatest confusion of light airs, calms, squalls, rain, thunder, and lightning of the most awful kind, together with waterspouts, &c., &c.

To the foregoing general remarks the following, respecting particular localities within the scope of the trade wind, are added. Further application of them will occur in the instructions for making passages, &c.

(48.) **WINDS ON THE ATLANTIC ISLES.**—The winds upon and near the different islands in the Atlantic Ocean are very variable and uncertain, especially where the land is high and irregular. In general, regular sea and land-breezes alternately prevail; the sea-breeze by day and the land-breeze by night, as the land is alternately heated and cooled; but the direction of these breezes is varied by the quality and figure of the land, and other local circumstances. If the land be very high, it generally intercepts the prevailing wind, and so affects the air as to produce, on the lee-side, either a calm, a gentle breeze in an opposite direction, or a kind of eddy, which is sometimes very troublesome to shipping. Such is the case under the western part of Madeira, and to leeward of the Canary Islands; the Grand Canary being so high as to stop the current of the N.E. wind which prevails there; and on the eastern side there is a calm, or a gentle breeze from S.W.

The calms and eddy winds, occasioned by the figure and height of the Canaries, extend from 10 to 30 leagues beyond them to the S.W., according to the height of the respective islands. The boundary of the calms may be seen; for, within them, the water is smooth; without them is the regular undulation of the sea, caused by the general wind; and at the end of them, the winds, by setting in opposite directions, produce a breaking of the waves with a foam, like the billows on a rocky shoal, just beneath the surface of the ocean.

From a consideration of the particulars now described, the cause of those copious dews which fall in the night on the islands, &c., situated within the tropics, will be apparent. For as the great power of the sun by day causes an extraordinary evaporation of the ocean, so, in the night, the exhalation,

ceasing to retain the same degree of levity acquired from the heat of the sun, becomes, by the absence of the power which produced it, so dense and heavy as again to fall back to the earth. The air at the same time cooling, by the same cause, is also affected by the descending moisture, and thus acquires an additional tendency to increase the land-breeze.

(49.) West Indies in general.—The following description of the winds prevailing over these regions, in the different seasons, has been extracted chiefly from Captain Livingstone's translation of the "Derrotero de las Antillas," or Spanish Directory for the West Indies.

On the eastern coasts of America, and among its islands, the course of the general easterly or trade wind is uninterrupted, though subject to some modifications in direction and force. At a short distance from the land the sea-breeze calms at night, and is replaced by the land-breeze. This variation happens every day, unless a strong wind prevails from the northward or southward; the first of these being experienced from October to May, and the second in July, August, and September.

The general easterly wind, of the tropical regions, is felt on the coast of Guayana, and on the coasts of the Colombian and Mexican Seas, but with variations which may be denominated *diurnal* and *annual*. The diurnal period is that which the sea-breeze causes, and which strikes the coast usually at an angle of two points, less or more, according to the locality and other circumstances; and then the land-wind, which, coming from the interior, always blows off shore. The sea-breeze comes on at about 9 or 10 in the forenoon, and continues while the sun is above the horizon, increasing its force as that luminary augments its altitude, and diminishing in a similar proportion as the sun's altitude decreases. Thus, when the sun is on the meridian, the sea-breeze is at the maximum of its strength; and at the time that the sun reaches the horizon this breeze has perceptibly ceased. The land-breeze commences before midnight, and continues until the rising of the sun, sometimes longer. A space of some hours intervenes between the land-breeze ceasing and the sea-breeze coming on, during which there is a perfect calm.

The *annual period* of the trade wind here is produced by the proximity or distance of the sun, which occasions the only two seasons known in the tropics, the *rainy* and *dry* seasons. The first is when the sun is in the tropic of Cancer, and heavy rains with loud thunder are prevalent. In this season the wind is generally to the southward of East, but interrupted by frequent calms, yet it occasionally blows with force, and obscures the atmosphere.

When the sun removes to the tropic of Capricorn, the dry season commences, and then the trade wind, which is steady at N.E., is cool and agreeable. At this season, N. and N.W. winds are sometimes found blowing with much force; and, indeed, in some degree, they regularly alternate with the general wind, as they are more frequent in November and December than in February and March.

In the change of the seasons there is a remarkable difference; for in April and May no change is experienced in the atmosphere, and the weather is, in general, beautifully fine; but in August, September, and October, there are

usually calms, or very light winds; and dreadful hurricanes in these months sometimes render the navigation perilous. From these perils, however, are generally exempted the Island Trinidad, the Coasts of Colombia (late Tierra Firma), the Bays of Darien and Honduras, and the Bight of Vera Cruz, which the hurricanes seldom reach. In the space of sea between the greater Antillas* and the Coast of Colombia, the general N.E. or trade wind regularly prevails; but near the shore local peculiarities are found.

(50.) **Jamaica.**—At Jamaica the air is, in most places, hot and unfavourable to European constitutions; but the cool sea-breezes, which set in every morning, render the air more tolerable; and that upon the high grounds is temperate, pure, and cooling. It lightens almost every night, but without much thunder; nevertheless, when the latter happens, it is very terrible, and roars tremendously.

On the northern side of the island the sea-breeze from the south-eastward comes on in the morning, and gradually increases until noon, when it is strongest; at two or three in the afternoon its force diminishes; and, in general, it entirely ceases by five o'clock. About eight in the evening the land-breeze begins; this breeze extends to the distance of 4 leagues to the southward from the island. It increases until midnight, and ceases at about four in the morning.

The sea and land-breezes are more regular than otherwise from the latter part of January until May. In the middle of May the sea-breeze generally prevails for several days and nights, especially about the time of full and change of the moon; and thus they continue throughout June and part of July; from that time the sea-breeze diminishes, varies, and veers round to S. by W., or S.S.W., with frequent calms. August, September, and October, are the hurricane months, in which there are generally strong gales of wind, with much rain.

In December, January, and February, when the North winds predominate, their force checks the sea-breeze. The southern coast is that which, of course, is least exposed to these winds, being sheltered, in a great measure, by the mountains. When combined with the land breeze they render the air very cold and unhealthy.

During the months of July and August, the sea-breeze about the island generally blows impetuously, and in frequent squalls. At this season vessels bound hence to Europe would have the most advantageous passage through the Strait and Stream of Florida; but in October northerly winds frequently extend over all the Bahamas, Cuba, and for some time on the North side of Jamaica; but the current of air is forced upward by the mountains of the latter, and its strength is spent in the heights. In seasons when it is more impetuous, it rushes through the windings and defiles of the mountains upon the northern coast, particularly in the neighbourhood of Kingston, and has been known to continue for some days.

During the winter the land-breeze is more general off the shores than in summer; it sometimes continues throughout the day as well as night; and westerly winds prevail over all the space between Jamaica and Cuba, and

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* Cuba, Jamaica, Hayti, and Porto Rico.

even to the Island of Hayti or St. Domingo. They have been experienced from Port Royal, through the windward channel; but this is not generally the case.

In November, southerly winds prevail on the South side of the island, and have been known to extend to the Mosquito shore, whence vessels have arrived in five or six days, that might, at other times, have been as many weeks, when beating against the sea-breeze. The southerly winds are generally faint; nor do they come upon the land until it be heated by the sun, and are often expelled by a fresh land-breeze soon after mid-day, which abates in a few hours.

The return of the sea-breeze, falling sooner or later in autumn, is gradual, first approaching at the East end, then advancing a little; and in some years it reaches Morant Point fourteen or twenty days before it is felt above Kingston. It also blows for a week or two later on the East end of the island than at Kingston; and has been known, in some years, to prevail there in the day time during the whole time it was unfelt at the former place.

(51.) The Bahama Islands are all within the influence of the trade winds. Their lowness, of course, exempts them from the regular land wind; but in the summer season a light breeze frequently comes from the Florida shore in the night, and reaches the western side of the Little Bahama Bank, but no further. At this period the wind generally prevails to the southward of East, and the more so as their N.W. extreme is approached; the weather is then very variable, and squalls rush down with great violence, accompanied with heavy rains and an oppressive atmosphere. They are within the zone of hurricanes, and a year seldom passes without their being visited by a heavy gale at least, from the S.E., which inflicts serious damage both on shore and at sea.

In the winter months, from about November till the middle of March, the trade wind is frequently interrupted by N.W. and North winds. In December and January this may be expected almost weekly. Previously to this change the wind will draw round to the South and S.W. In about twenty-four hours, or less, dark masses of clouds will be seen rising from the westward, and in a short time the wind will rush down suddenly from that quarter with the force of a double or triple-reefed top-sail breeze. It will soon veer round to the N.W. and North, with clear weather, and remain between these points two or three days. It will then haul gradually to the N.E., perhaps with increased force, accompanied by heavy squalls, and wear itself out at East in the course of a few days. The barometer is scarcely any guide.

(52.) Among the local winds are to be ranked the *Bayamos*, violent gusts which blow from the land on the South side of Cuba, and are so termed from being felt more severely off the *Bight of Bayamo* or *Buena Esperanza*, than off any other part of the coast.

When heavy and dense clouds gather over the mountains, a Bayamo blast may be expected; after this, the surest prognostic is the thunder, which invariably precedes the gust; it is therefore advisable to take in all sail with the greatest expedition, so soon as the first or more distant clap of thunder is heard, the wind following it almost immediately. Fortunately, however,

these dreadful squalls are of short duration; but, as a repetition of them frequently occurs at intervals of half an hour or an hour, great attention is necessary, especially during the night, to prevent the ship being unprepared; as it is almost certain that, if she were overtaken by one of these squalls whilst under sail, she would either upset or lose her masts.

These sudden tempests are attended with sheet and forked lightning, vivid in the extreme; and the flashes following each other in quick succession, have the momentary effect of illuminating every object, and leave behind them a sort of blue indescribable appearance; the sea is whitened with foam, and the rain falls in torrents, surpassing any, perhaps, witnessed in other regions; for it appears as if the clouds had opened their store of waters to deluge the earth; in fact, we cannot better describe the extreme heaviness of the shower, than by giving the sailor's observation on it, namely, that it "comes down by buckets full." The Bayamo squall, however, although the most awful of any in the Caribbean Sea, and creating much anxiety to those exposed to its fury, is grand and sublime.*—*Lieut. Evans*, "Revision of Geographic Terms," p. 107.

(53.) On the **Coasts of Guayana**, the *Derrotero* again continues; there are no land-breezes, nor more wind than is generally experienced between the tropics. In January, February, and March, the winds here blow from North to E.N.E., and the weather is clear. In April, May, and June, the winds are from E. to S.E. In July, August, and September, there are calms, with tornadoes from South and S.W.; and in October, November, and December, there are continued rains, while the sky is, in general, obscured by clouds. In the dry season, which is from January to June, the heat is very great; and in the wet season, from August to November, rains and thunder are constant and violent.

On the *Coasts of Cumana* and *Caraccas*, to Cape la Vela, the breeze follows the regular course; but from that cape to Cape San Blas, the general wind alters its direction; for it blows from N.E. or N.N.E., excepting in the months of March, April, May, and June, when it comes to E.N.E., and is then so uncommonly strong as to render it necessary for vessels to lie-to. These gales, which are well known to mariners, extend from about mid-channel to within 2 or 3 leagues of the coast, where they become weak, especially at night. On this coast, about the *Bay of Nicaragua*, are westerly winds, which the pilots of that country call *Vendavales* (rainy winds), in the months from July to December, but these winds never pass the parallel of 13° N., nor do they blow constantly, but alternate with the sea-breeze.

Upon the *Mosquito Shore*, *Honduras*, and *Eastern Coast of Yucatan*, the general winds or breezes prevail in February, March, April, and May; but,

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* The winds on the South Coast of Cuba, when the trade is not blowing steadily, have a remarkable rotary motion following the course of the sun, according to Dove's Law of Gyration (17). Thus, in the evening, the wind comes off the land about N.; by daylight it will be N.E.; at 8 a.m., E.N.E.; at noon, E.S.E.; at 2 p.m., South; at 4 p.m., S.W.; in which quarter it generally dies away into a calm until the land-wind comes off again. By a knowledge of this a vessel may creep fast to windward during the calm months of May, June, and August, and frequently at other seasons. The trade is found to be unsteady, especially in the night.

during the first two of these months, they are occasionally interrupted by *Norths*. In June, July, and August, the winds here are from the eastward and westward of South, with tornadoes and calms. In September, October, November, December, and January, they are from the northward or southward of West, with frequent gales from W.S.W. and N.

On the *Coast of the Mexican Sea*, from *Vera Cruz* to *Tampico*, the breeze from E.S.E. and East prevails in April, May, June, and July; and at night the land-breeze comes off from South to S.W.; but if the land-breeze is from the N.W., with rain, the wind, on the day following, will be from North, N.N.E., or N.E., particularly in August and September; these winds are denominated, in the country, *Vientos de Cabeza o Vendavales* (head or down-coast winds); they are not strong, nor do they raise the sea; with them, therefore, a vessel may take an anchorage as well as with the general breeze; but they impede getting out, for which the land-breeze is required. The *Vientos de Cabeza*, or head winds, reach to about 20 or 30 leagues from the coast, at which distance are found those at East and E.S.E.

(54.) From the middle of September until the month of March, caution is necessary in making *Vera Cruz*, for the Norths are then very heavy. The narrowness of this harbour, the obstruction formed by the shoals at its entrance, and the slender shelter it affords from the Norths, render an attempt to make it, during one of them, extremely dangerous, for it will be impossible to take the anchorage. The following description of the winds here has been written by Don Bernardo de Orta, a captain in the Spanish Navy, who has been captain of the port, and who surveyed it.

Although in the Mexican Sea it cannot be said that there is any other constant wind than the general breeze of this region, yet, from September to March, the North winds interrupt the general course, and in some degree divide the year into two seasons, *wet* and *dry*, or of the *Breezes* and *Norths*; the first, in which the breezes are settled, is from March to September; and the second, in which the Norths blow, is from September to March. For greater clearness we shall explain each separately.

(55.) **The Norths.**—The first of the Norths is regularly felt in the month of September; but in this month and the following one, October, the Norths do not blow with much force. Sometimes it happens that they do not appear: but, in that case, the breeze is interrupted by heavy rains and tornadoes. In November the Norths are established, blow with much strength, and continue a length of time, during December, January, and February. In these months, after they begin, they increase fast; and in four hours, or a little more, attain their utmost strength, with which they continue blowing for forty-eight hours; but afterward, though they do not cease for some days, they are moderate. In these months the Norths are obscure and north-westerly, and they come on so frequently that there is, in general, not more than four or six days between them. In March and April they are neither so frequent, nor last so long, and are clearer, but yet they are more fierce for the first twenty-four hours, and have less north-westing. In the interval before November, in which, as we have said, the Norths are established, the weather is beautiful, and the general breeze blows with great regularity by day; the land-breeze as regularly by night.

There are various signs by which the coming on of a North may be fore-

seen: such are, the wind steady at South; the moisture of the walls, and of the pavements of the houses and streets; seeing clearly the Peak of Orizaba, and the mountains of Perote and Villa Rica, with the cloud on those of St. Martin, having folds like a white sheet; the increase of heat and of dew; and a thick fog, or low scud, flying with velocity to the southward; but the most certain of all is the barometer; for this instrument, in the time of the Norths at Vera Cruz, does not vary more, between its highest and lowest range, than ·80, that is to say, it does not rise higher than 30·6 inches, nor fall lower than 29·8 inches. The descent of the mercury predicts the Norths; but they do not begin to blow the moment it sinks, which it always does a short time before the North comes on. At these times lightnings appear on the horizon, especially from N.W. to N.E.; the sea sparkles; cobwebs are seen on the rigging, if by day. With such warnings trust not to the weather, for a North will infallibly come on.

This wind generally moderates at the setting of the sun; that is, it does not retain the same strength which it had from nine in the morning to three in the afternoon, unless it commences in the evening or at night, for then it may increase. Sometimes it happens that after dark, or a little before midnight, it is found to be the land-wind, from the northward and westward; in which case, should it get round to the southward of West, the North will be at an end, and the general breeze will, to a certainty, come on at its regular hour; but, if that does not happen at the rising of the sun, or afterward, and at the turn of the tide, it will return to blow from the North, with the same violence as on the day before, and then it is called a *Norte de Marea*, or *Tide North*.

The Norths also sometimes conclude by taking to the northward and eastward, which is more certain; for if the wind in the evening gets to N.E., although the sky remain covered the day following, but by night the land-breeze has been from the northward and westward, the regular breeze will surely ensue in the evening, good weather succeeding and continuing for four or six days; the latter period being the longest that it will last to, in the season of the Norths; but if the wind retrograde from N.E. to N.N.E. or North, the weather will be still unsettled.

Examples are not wanting of Norths happening in May, June, July, and August, at which times they are most furious, and are called *Nortes del Hueso Colorado*; the more moderate are called *Chocolateros*, but these are rather uncommon.*

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* From the late Lieutenant John Evans (*a*), R.N., (a gentleman to whom we were indebted for many valuable communications), we received the following description of a *North* in the Mexican Sea, which occurred in March, 1828:—

"We had observed, during our run over the Catoche Bank, a very extraordinary white hazy-like appearance, very distinct from the common fog, haze, or mist. This was seen principally in the northern quarter, and attracted much notice; the air, at the same time, 'breathing gently at South,' and the sympiesometer falling unusually low, gave us strong indications of an approaching *North*. On the 15th there appeared on the sky only a few small *cumuli* and dark *strati*; in the morning the air was very light from the South, and was so warm, or rather hot and oppressive, that, like the *sirocco*, it affected the breathing of some of us. At 10 a.m. it changed to the N.E., with fine weather, the wind gradually

(56.) The *Wet Season*, or *Season of the Breezes*, is from March to September, the breezes at the end of March, and through the whole month of April, as already explained, are, from time to time, interrupted by Norths, and are from E.S.E., very fresh; the sky sometimes clear, at other times obscure. At times these touch from S.E., and continue all night, without giving place to the land-breeze, which prevails in general every night, excepting when the North wind is on. The land-breeze is freshest when the rains have begun.

After the sun passes the zenith of Vera Cruz, and until he returns to it, that is, from the 16th of May to the 27th of July, the breezes are of the lightest description, almost calms, with much mist or haze, and slight tornadoes. After that time the pleasant breezes from N.W. to N.E. sometimes remain fixed.

From the 27th of July to the middle of October, when the Norths become established, the tornadoes are fierce, with heavy rains, thunder, and lightning; those which bring the heaviest wind are from the East, but they are also those of the shortest duration.

In the season of the breezes the total variation of the barometer is 0·4; the greatest ascent of the mercury is to 30·36 inches, and its greatest descent to 29·96 inches. The thermometer in July rises to 87°, and does not fall to 82½°. In December it rises to 80½°, but never falls below 66½°. This, it must be understood, was ascertained in the shade, the instrument being placed in one of the coolest and best ventilated halls in the castle.

In the months of August and September, rarely a year passes without hurricanes near Florida and the Northern Antillas; but to Vera Cruz, or any part of the coast thence to Campeché, they never arrive; all that is felt being the heavy sea, which has arisen in the higher latitudes. Hurricanes begin to the eastward and northward; and, although they do not always go round the same way, yet, in general, they next go to the southward and eastward, with thick squally weather and rain.

From *Tampico* to the *Bay of San Bernardo*, breezs from the southward and eastward are steady and pleasant from April to August; but, in the remaining months, this coast is much exposed to gales from the East and E.S.E., which blow without intermission for two or three days, before a North comes on. In about latitude 26½°, there are land-breezes in the summer, which blow from midnight until nine in the forenoon.

(57.) Gulf of Mexico, North Coast.—A series of observations on the winds and tides were made by the officers of the U.S. Coast Survey, between June, 1847, and July, 1852. The force and direction of the wind were noted at three stations—at Galveston, in Texas, lat. 29° 18′ N., long. 94° 46′ W.; at

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freshening. At sunset the *cumuli* changed into dark *nimbus*, of a deep purple, edged with a bronze colour; from these clouds proceeded squalls with rain, the wind veering from N.E to N.N.W., after which it cleared up, the clouds all dispersed, and at 8 p.m. a fresh *North* came on, with a rapidly-rising sea (which a short time before had been perfectly calm and smooth). The sympiesometer fell to 29·80, which was lower than it had ever done before. It blew a gale all night, with a heavy sea; no clouds; the stars bright and large. The same white hazy-like appearance took place before the *North* set in. Early in the morning of the 16th the wind died away suddenly, almost to a calm; and at 8 a.m. became a moderate breeze."

Fort Morgan, Mobile Bay, about the middle of the North coast, in lat. 30° 13′ N., long. 81° 0′ W.; and at Kay West, one of the Florida Kays, in lat. 24° 38′, long. 84° 48′ W. These observations, however, have the same imperfection as that noticed in the note (*) on page 200—that the winds are not recorded equally for all points of the compass. However, the following general remarks are useful and interesting as derived from these observations, and are arranged in the form of diagrams, which need not be repeated here.

(a) Winds from some northern quarter prevail from September until February, both inclusive, and southwardly winds from March to August, inclusive. Winds from the eastward prevail throughout the year, except at Fort Morgan, in May, June, July, and August, when the sea-breeze is from the S.W. In the whole year the winds from the same quarter, North and South, balance each other nearly, while the eastwardly wind greatly predominates over the westwardly.

(b) As remarked in my former paper, the months may be arranged, according to the prevailing winds, into the following classes:—The winter, consisting of December and January; the spring, of March and April; the summer, of May, June, and July; of preparation for change, August; the autumn, of September, October, and November.

The winter and summer types are extremely distinct. At Kay West, in December and January, N.E. and North are the prevailing winds; at Fort Morgan, North, E.S.E., and East; at Galveston, North and N.W.; then E.N.E. and S.E. I suppose the general course of the N.E. trade wind to be disturbed by local action at Fort Morgan and Galveston, the local position of greatest warmth being the gulf.

The summer type, May, June, and July, gives S.E. as the prevailing wind at Kay West; the S.E., South, and S.W. (sea-breeze), at Fort Morgan; the South, S.E., and East, at Galveston, blowing towards the land.

August resembles July, with the appearance of winds which prevail in the autumn.

In September, October, and November, at Kay West, E.N.E. prevail; at Fort Morgan, North, N.E., and East; and at Galveston, North, N.E., East, and N.W.

In March and April, the spring period, S.E., S.S.E., and East winds prevail at Kay West; North, S.S.E., and E.S.E., at Fort Morgan; and North, S.E., and South, at Galveston.

February resembles January, with a preparation for the spring period; and, like August, it is characterized at Fort Morgan and Galveston by a general diminution in the quantity of wind.

January presents the full winter type of the winds on the gulf; and June and July the full summer type. The changes are quite gradual, and tolerably regular, from one extreme to the other.

(c) The following deductions are made from these observations in regard to the least and greatest quantities of wind in the principal directions in different portions of the year.

The North wind is a minimum at the three places in July, and a maximum in January. It is a very remarkable feature at all three places in J

The N.W. almost dies out at all three from May to September, first gaining strength at Galveston, in October, and reaching its maximum in all the places in December. Its quantity at Kay West and Fort Morgan is small when at the maximum.

The northers and north-westers both appear in force in April, at Galveston. There is very little West wind at either place, but more at Fort Morgan than either of the others, and chiefly during the months of June and July.

South-west wind is of rare occurrence except at Fort Morgan, where it constitutes the sea-breeze of summer, and reaches its maximum in June and July, suddenly diminishing in September.

There is but little South wind at Kay West; at Fort Morgan it increases in amount in the spring, and is the greatest in June. It is decidedly a marked feature as one of the prevailing spring winds at Galveston, reaching its maximum in May, and becoming quite small in August, re-appearing in the winter, and rapidly increasing in March.

The N.E. wind is a minimum at the three places in July and August; is largest in quantity in September, October, November, and December, at Kay West; in September and October, at Fort Morgan; and in September, December, and January, at Galveston. The sudden increase of this wind in September, after its small quantity in August, is remarkable at all three places.

The winds intermediate between N.E. and S.E. occur during the changes from N.E. to S.E., and it would be of little value to refer to the greatest and least quantities.

The S.E. wind is a minimum in December and January at Kay West; in January and February at Fort Morgan; in December and January at Galveston. It is a maximum at Kay West in July; but, being replaced during the summer to a great extent by the sea-breeze (S.W) at Fort Morgan, makes its minimum in November, and at Galveston in May, doubtless from the disturbing effect of the land; it is again large in July. This is the sea-breeze of Kay West, and as well as the South wind, that of Galveston.

(d) The movement of the prevailing wind at Kay West, where the disturbing causes of the land are the least, is very instructive.

The prevailing wind in April, May, June, and July, is the S.E., hauling to the eastward in August, and becoming E.S.E. In September and October it passes farther North to E.N.E., and in November and December becomes N.E.; in January it reaches North; returning southward in February, it is N.N.E., in March East, and reaches the S.E. in April. The local action is thus seen to prevail for the greater part of the year over the general. For the whole year the S.E. wind exceeds any other from an eastwardly point.

The eastwardly wind at Fort Morgan reaches no farther South than E.S.E. in the spring and summer. In September the prevailing wind is N.E., passing to E.N.E. in October, and back to E.S.E. in the winter and spring. The general tendency for the year is then E.S.E.

The changes at Galveston resemble those at Kay West, the general absence of E.N.E. and E.S.E. winds being due to defects in the observations.

In the Strait of Florida the breezes are the prevailing winds, but they are interrupted by Norths in the winter, and by calms in the summer. Although the northern limit of this channel is within the boundary of the trade wind, it is necessary to remember that in winter, or from November till April, the variable winds from the southward and eastward, and southward and westward, are met with in lat. 27°, and even before; and in summer, from May until September, the winds in the whole channel are variable from the southward and eastward, and southward and westward.

4.—EQUATORIAL CALMS AND WINDS.

(58.) The N.E. and S.E. trade, blowing towards each other, meet and are neutralized near the Equator (6). This neutral line of calms and varying winds is sometimes known by the name of the "Doldrums," an uncouth term, which, we think, has had unmerited authority given to it. It is, perhaps, a corruption of the Spanish *doloroso*, or old Portuguese *doloris*, "tormenting."

Com. Maury says, "This region of doldrums has a mean average breadth (around the globe) of about 6 degrees of latitude. In this region, the air which is brought to the equator by the N.E. and S.E. trades ascends. This belt of calms always separates these two trade wind zones, and travels up and down with them. If we liken this belt of equatorial calms to an immense atmospherical trough, extending as it does entirely around the earth; and if we liken the N.E. and S.E. trade winds to two streams discharging themselves into it, we shall see that we have two currents perpetually running in at the bottom, and that, therefore, we must have as much air as the two currents bring in at the bottom to flow out of the top. What flows out of the top is carried back North and South by these upper currents (6), which are thus proved to exist and to flow counter to the trade winds."

This belt of calms follows the sun in his annual course, though the limits do not range so much in latitude as the sun does in declination; and generally, they pass from one extreme of latitude to another in about three months. The whole system of wind and calm belts move northward from the latter part of May till some time in August; they then remain almost stationary till the approach of winter, when they commence to go southward, and proceed in that direction from December to February or March.

"The great '*sun swing*' of this calm belt," says Capt. Maury, is annual in its occurrence; it marks the seasons, and divides the year into wet and dry for all those places that are within the arc of its majestic sweep. But there are other subordinate and minor influences which are continually taking place in the atmosphere, and which are also calculated to alter the place of this calm belt, and to produce changes in the thermal status of the air which the trade winds move. These are unusually severe winters or hot summers; remarkable spells of weather, such as long continuous rains or

droughts, over areas of considerable extent. Either within or near the trade wind belts it is tremblingly alive to all such influences, and they keep it in continual agitation; accordingly we find that such is its state, that, within certain boundaries, it is continually changing place and limits. This fact is abundantly proved by the speed of ships, whose log-books show that it is by no means a rare occurrence for one vessel, after she has been dallying in the doldrums for days, in the vain effort to cross that calm belt, to see another coming up to her 'hand over fist,' with fair winds, and crossing the belt after a delay in it of only a few hours instead of days." *

(59.) These remarks of Capt. Maury, coupled with the experience of most sailors who cross the line, will demonstrate that the limits of this calm belt cannot be very exactly defined, and it is only the doctrine of chances that can determine when any particular ship will lose the trades, and encounter these doldrums.

On page 203 (47), is given the table drawn up by Captain Horsburgh, as the probable equinoctial limits of the N.E. and S.E. trades, and consequently of the intervening belt of calms. This applies to that part of them, between 18° and 26° W., which was usually traversed by the East India Company's ships. The chart facing page 195, and also that illustrating Captain Toynbee's monthly discussion of the winds between 10° S. and 20° N., and from 10° W. to 40° W. (47), pp. 203—207, will serve to assist the seaman in quickly finding the latitude in which he may expect to fall in with these troublesome winds. In the chapter on Passages, the routes recommended for crossing the equator will be found. The following approximate estimate of the breadth of this calm belt is derived from Maury's Trade Wind Chart, &c, and given in the Hydrographic Office Pilot Charts, and also by Dr. Van Galen.† It is of course in a measure superseded by the work of Captain Toynbee, mentioned above, but is given here as it may be useful taken in connection with that work, in showing the amount of reliance which may be placed on these deductions: —

* "Physical Geography of the Sea, 1860," p. 358.

† "Zeil, Wind en Stroomkaarten Toegelicht," door Dr. P. van Galen. Rotterdam. 1859.

TABLE *of the Average Extent of the Equinoctial Calms.*

Month.	Limits.	50° to 45° W.	45° to 40° W.	40° to 35° W.	35° to 30° W.	30° to 25° W.	25° to 20° W.	20° to 15° W.
January.	N.	3° N.	3° N.	2° N.	2° N.	3° N.	3° N.	6° N.
	S.	—	3	2	2	0	1	1
February.	N.	3	3	2	1	3	4	6
	S.	—	3	2	1	1 S.	0	0
March.	N.	3	2	0	1	2 N.	4	5
	S.	—	2	0	0	2 S.	1 S.	0
April.	N.	3	2	1 S.	1	2 N.	3 N.	6
	S.	—	2	0	0	2 S.	1 S.	0
May.	N.	4	4	3 N.	3	4 N.	5 N.	6
	S.	—	4	1	1	1 S.	0	1
June.	N.	6	6	6	8	9 N.	8	9
	S.	—	4	1	2	0	1	1
July.	N.	8	9	9	11	11	12	—
	S.	—	5	3	4	2	2	1
August.	N.	11	12	12	12	12	13	—
	S.	8	6	4	4	2	2	1
September.	N.	11	12	12	10	12	12	—
	S.	8	6	5	4	2	1	1
October.	N.	10	10	10	10	10	11	—
	S.	7	6	5	4	2	1	1
November.	N.	6	6	6	6	6	8	10
	S.	6	6	5	3	2	1	1
December.	N.	2	4	4	3	4	5	7
	S.	—	4	4	3	1	2	1

This table will show that, during the winter months, and in the western part of the ocean, the limits of the trade winds (which is that given in the table) approximate, and leave no interval of calm. In the northern summer months, however, the calm belt is much more distinctly marked, although its mean breadth is not one-third or one-half what it is on the eastern side. This fact is also graphically explained by the diagram facing page 195. As we said before, on page 198 (40), the limits of the trades vary to the extent of 10° of latitude, and therefore the figures given in the preceding table can only be taken as a possible approximation.

There is one remark which it may be as well to urge here: that, as this belt of calms runs East and West, the navigator will clear them soonest by making a direct *Southern* or *Northern* course, as far as possible, as he thus runs directly across them; by beating too much East or West he is retarding himself in that direction.

(60.) In modern navigation, a calm is almost more to be dreaded than a storm; for in the former a sailing ship is helpless, and in the latter her great sailing powers, and the many appliances now available, suffice to

disarm the fury of many ordinary gales. It is, therefore, of primary importance that the commander should be aware of what spaces are subject to calms in different seasons, and by this knowledge carefully avoid their detaining and troublesome influences. It is to this knowledge that the improvement of the trans-equator passage must be looked for. It has been strongly advocated, of late years, that a much more westerly crossing should be taken than was adopted in former years; but it very frequently happens that the accounts of the voyages in one month abound with bitter complaints against this western crossing, while those of another season are equally full of its praises. This topic will be more fully dilated on hereafter, in the chapter devoted to general sailing directions. It will suffice here to give a general insight into the areas of calm and baffling winds that exist in this equatorial belt, and especially in that part of it where the S.W. African monsoon is felt; and in that part of our subject some further remarks will be found.

(61.) But little has been said as yet about barometric indications. They will be more especially alluded to hereafter. In an excellent discourse given by Captain Toynbee, at the United Service Institution, May 19th, 1871, the following passage occurred, which will be in place here:—

"The ship from England, bound across the Equator, finds the wind to draw more northerly as she approaches the southern verge of the N.E. trades; whilst, after passing through the equatorial calms, the S.E. trades commence at South. It is also found that as this zone of doldrums is approached, the barometer falls; it is an area of low pressure; and the zone of equatorial doldrums travels with it between the Equator and 10° or 12° N. during the year.

"Into this zone the air seems to blow from North to South, whilst the pressure still remains lower than on either side; we have, therefore, reason to suppose that here, on the border line of two hemispheres, the air is drawn directly towards the lowest pressure. It will be remembered that, at a certain distance from the Equator in the northern hemisphere, the air draws round an area of low pressure, keeping the lowest pressure to its left, whilst at a certain distance from the Equator in the southern hemisphere, this order is reversed, and the lowest pressure is to the right of a person standing with his back to the wind. Hence it is reasonable to expect that the air will move directly for the area of lowest pressure in a part where the two hemispheres meet.

"We have now treated of the more permanent areas of high and low pressure in the North Atlantic; and here let me add, that similar areas of high and low pressure are found to exist in the other great oceans. If these areas were quite fixed, and the only disturbances to which the air of the North Atlantic was subjected, the direction and force of the wind might be expected to be equally fixed. But, besides the above, local and temporary disturbances are very common."

(62.)—The trade winds are essentially *evaporating* winds. From their high temperature, in passing over a large extent of ocean, they become loaded with aqueous vapour, which becomes evident when they meet and neutralize each other in this zone of equatorial calms.

The result is the formation of the "*cloud ring*" of Captain Maury, which

he likens to the rings of Saturn or the belts of Jupiter. Under this oppressive and constant companion of the equatorial calm the rain falls in torrents, and by the progress of the sun in the ecliptic it causes the phenomena of the tropical seasons, divided, as is well known, into the wet and dry. A consideration of the chart and the shifting of this belt will explain how it is that some places have two rainy seasons and others only one, by the passing of the cloud ring over them.

"It is broader than the belt of calms out of which it arises. As the air with its vapours rises up in this calm belt and ascends, these vapours are condensed into clouds, and this condensation is followed by a turgid intumescence, which causes the clouds to overflow the calm belt as it veers both to the North and South. The air, flowing off in the same direction, assumes the character of winds that form the upper currents that are counter (5) to the trade winds. These currents carry the clouds still further to the North and South, and thus make the cloud ring broader. At least, we infer such to be the case, for the rains are found to extend out on to the trade winds, and often to a considerable distance North and South of the calm belt."

This oppressive region, most tedious to navigators, is, however, not at all times subject to this great amount of deposition, which has procured for it the appellation of "*The Rains;*" and especially during the winter months, when its extent is more limited, it may be crossed without encountering either those torrents of rain, or almost unbearable calms. This compensating belt to the evaporation of the trades, of course, is subject to squalls, and especially to thunder-storms, the natural result of the conflicting elements. Altogether, its effect on the health and spirits, its enervating influences, its oppressive and damp heat, make it one of the most unpleasant parts of the globe.*

5.—THE AFRICAN MONSOONS.

(63.) The influence of the land upon the trade winds, and the intervening calms, is very powerful on the eastern side of the Atlantic; and the peculiar configuration of the coast of Guinea, trending as it does along the very axis or line of division of the northern and southern wind systems, causes a different set of phenomena to arise. During that part of the year when the sun is in the southern hemisphere, the trades and calms follow the normal or usual course, as it is then exerting its maximum force on the sea with its

* Attention to personal cleanliness is very important during the detention caused by these calms. Dampier gives a quaint description of the ill effects of his men not drying their clothes and lying down on their hammocks while wet, which caused all to become offensive and open to attacks of disease. Captain Maury says, "The emigrant ships from Europe to Australia have to cross it. They are often baffled in it for two or three weeks; then the children and passengers who are delicate in health suffer most. It is a frightful graveyard on the wayside to that golden land."

low absorptive and radiative powers; but when, during the northern summer, it is raising the temperature of the land of the Guinea coast, a new phase arises from the heated almosphere over the land drawing the wind towards it; and instead of a S.E. or N.E. wind, we have a South and S.W. occurring with great regularity. Major Rennel says, "In the space lengthwise, between Cape Verde and Cape Mesurado, and in certain places to the extent of 70 leagues off shore (50 off Sierra Leone), a regular change of winds and currents takes place, according to the seasons; that is to say, a N.E. or North wind and S.E. current, from September to June; and in the rest of the year, S.W. wind and N.E. or northerly currents, in effect a *monsoon;* and this extends, in respect of the *wind*, nearly through the whole space between the two continents."*

(64.) In Dampier's Discourse on the trade winds, and his illustrative Chart (1697), we find a solution of the origin of these S.W. winds, which is that still held to be most feasible. It is, that they are derived from the S.E. trades, and not from a diversion of the N.E. trades. This also has been suggested in the "Mercantile Marine Magazine," of 1856, the data being derived from Maury's charts. An important element in determining the reality or otherwise of this suggestion is the position of the calms. Are they interposed between the N.E. trade and monsoon, or between the monsoon and S.E. trade? But this consideration may not have great weight in this region of calms, and besides the probability of this origin is increased by the data for the direction of the S.E. trade, which is shown not to blow with regularity to the East of a line joining Cape Palmas and Angola.

(65.) There is another conclusive evidence of the westerly extension of the monsoons in the *easterly* current that is met with almost constantly during the seasons of their prevalence. These are very persistent as far as longitude 40° W., and are at times encountered as far North as latitude 16°, but more usually between lats. 6° and 11° N. This origin of the anomalous Guinea Current was indicated in our chart of the Atlantic, published in 1858. A similar current is shown to exist in the Pacific Ocean, West of Panama Bay. This feature will be further dilated on when we come to the Section on Currents.

(66.) These South, S.S.W., and S.W. winds prevail, according to Maury's Pilot Charts, chiefly during the months of July, August, September, and October, and are then felt as far to the westward as 35° or 40° W., between the parallels of 5° and 8° N. In the western tract of this area they diminish in frequency as the sun proceeds to the South, and are scarcely felt in the North Atlantic during the months of December, January, and February. The chances of encountering this adverse wind must have an important bearing on the choice of a route for crossing the equator during these months, but we leave this subject to be discussed under the heading of Crossing the Equator, in the chapter on passages given hereafter. Between December and April, which is the season most visited by calms,

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* The existence and character of this S.W. African monsoon was thus early recognized and named (at the latter end of last century). The term "*newly-discovered*" monsoons, give to them by our American friends, is therefore not quite applicable.

the wind has still a southern tendency; but, during the season of the monsoon, the calms are at a minimum near the coast. It is difficult to explain in words the relative duration, force, or frequency, of the winds in this changeable locality, without an appeal to the chart. The reader is referred to that illustrating the winds of the region between 20° N. and 10° S., and to the chart of the North Atlantic, in four sheets, before alluded to.

(67.) The following remarks, by the late Captain Midgley, who had great experience on the African coast, will be found of service in explaining the character of the winds and seasons:—

I will here offer a few remarks on the general variable winds and weather which prevail between the parallels of 4° and 10° N., and the meridians of 18° and 25° W., or between the N.E. and S.E. trade winds.

The winds generally incline from the southward, between the trades, and few vessels pass from one trade wind to the other without meeting with very unpleasant weather, in the shape of calms, light baffling winds, squalls, and rain, particularly when the sun is much to the northward.

In June, July, and August, heavy squalls seem to prevail from the S.W., with a great deal of rain, and the wind often blows hard from this quarter for several hours together, and then falls calm, leaving a heavy and confused short sea, which cause a vessel to labour and strain more than she would do in a gale of wind.

When the sun is far to the southward, the weather is comparatively fine, with light southerly and S.E. winds, occasionally, however, interrupted by squalls and rain; and the calms are of shorter duration, owing, probably, to the limited breadth of the space between the trade winds at this season.

In this part of the ocean, when much lightning is seen in a heavy dense cloud, in any quarter of the compass, the wind may be expected to come out suddenly from that quarter, especially if there is any rain, even though the wind may be blowing at the same time with moderate force from an opposite quarter.

Forked or chain lightning is the almost sure forerunner of a heavy squall; it is a monitor whose warning should not be neglected.*

Whenever there is much lightning, and the wind is unsteady and baffling about, prepare for a change. A heavy dense cloud, having a squally appearance, may rise and pass slowly over the vessel directly to leeward, with perhaps little or no increase of wind; and when the danger may be supposed over, the vessel is suddenly taken aback with a smart squall. This, I presume, arises from the cloud which has just gone over the ship, being opposed in its progress to leeward by a stronger current of air from the opposite quarter. On this account, when clouds are in motion from opposite quarters of the compass, a better look-out, if possible, should be kept to leeward than to windward.

Keeping a good look-out upon the surface of the water is an excellent

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* In those parts of the North Atlantic Ocean which are not in the general influence of the trades, I have very frequently remarked that lightning is indicative of a change of wind.

method of judging of the force of the wind in an approaching squall; but, on account of the heavy rain which invariably accompanies the squalls alluded to, very little sound judgment can be exercised with respect to their strength; they are generally, however, tolerably heavy, and require sail to be considerably reduced.

In June, July, and August, the weather is very wet and squally. Sometimes dense masses of clouds are seen in rapid motion from the S.E., southward, and S.W. quarters of the horizon: these clouds have a bulky and confused appearance, as if tumbling or rolling over each other; are of a dirty dark drab colour, with ragged edges, and inky-looking small clouds flying about the edges of them. In their approach towards the zenith they gradually appear to unite and form the apex of an angle, and, thus united, blow with incredible violence from the S.W. quarter (veering about two or three points or more) for upwards of two hours, during which time the rain descends in torrents, perhaps accompanied by a waterspout or whirlwind.

Ships should be well prepared for these dangerous visitors; for they come with a similar violence to the arched white squall of the West Indies. I have experienced two squalls of the above description (both in the month of July), and in one of them lost a good fore-topsail, after the reef tackles, &c., were hauled out snug, and the ship had been for some time running directly before the wind. Upon both occasions my barometer fell three-tenths of an inch very suddenly, which enabled me to take in sail in time; for the squalls did not look particularly alarming until about eight or ten minutes before they reached the ship.

To the inexperienced in this part of the ocean, I would beg to remark, that *much* sheet lightning is always suspicious, and forked or chain lightning universally so; and the latter is, in some degree, indicative of a change, as of an increase of wind.

After the wind has blown steadily, with fine weather for a few hours, and it then begins to be variable, and fly suddenly about, squalls and rain may be expected.

The moon has great influence on the weather; for it is most squally and unsettled, with much rain, about the full and change.

I perfectly agree with Captain Cheveley, that the month of July is, perhaps, the worst in the year for making southing between the trades.

(68.) *Between Cape Blanco and the entrance of the River Gambia*, during the months of November, December, January, February, and March, the winds from the East and N.E. are prevalent. In this time the nights are cool; but scarcely has the sun arisen above the horizon, when the air becomes dry and parching. Nevertheless, these five months are the winter in this part of Africa, and this is the most healthy season. Between the Gambia and Cape Palmas the inland winds, during the same season, are variable.

In June, July, August, September, and October, the country situated between Cape Verga and Cape Mount is much exposed to hurricanes or tornadoes. These, however, do not occur in any part of the coast northward of Cape Verga.

From the 20th degree of North latitude to the environs of the line, the atmosphere emits its waters to the earth; the only difference is, twenty

days sooner or later in the arrival of these torrents. During the other eight months in the year there does not fall a single drop of water.

Between the *Cape Verde Islands*, and in their neighbourhood, southerly and S.W. winds generally blow in July, August, September, and October. These islands, when the sun is in their zenith, are generally surrounded by thick fogs.

From *Sierra Leone to Cape Palmas* the ordinary course of the winds on the coast is from W.N.W., and beyond Cape Palmas, from W.S.W. to S.W. and S.S.W.

Although, in the Gulf of Guinea, the wind blows generally from the southward, and S.S.W. toward the coast, they take, in South latitude, a more westerly direction near the land, and then prevail from S.W. and W.S.W. between Cape Lopez and Benguela. But they veer proportionally more southerly as the distance increases from the coast.

Windward Coast, &c.—The name of *Windward Coast* has been given by our navigators to the whole of that coast which extends from Cape Mount to the River Assinee, where the Gold Coast commences; it includes the three particular coasts called, 1st. Grain, or Pepper Coast; 2nd. Ivory, or Teeth Coast; 3rd. the Coast of Adou, or Quaqua.

From January until May, the weather here, along shore, is commonly fair and clear, with cooling breezes, and gentle southerly winds. But about the middle of May, South and S.E. winds begin, accompanied not only with hurricanes and stormy gusts, but also with thunder, lightning, and great rains, which continue, more or less, until the conclusion of the year.

On the Gold Coast, from Assinee to the River Volta, the wind in January begins to blow from the S.W. quarter, and becomes stronger in February, bringing with it sometimes rain, and sometimes a hurricane. About the end of March, and beginning of April, those heavy tempests, called by the Portuguese *tornadoes*, arise, accompanied with a deluge of rain, thunder, and lightning; these continue to the end of May, and are announced by the darkness of the sky in the S.E.

During the rainy season, that is, in May and July, little or no land-winds are felt; but from the sea it blows from the S.W. and W.S.W., making a very great swell, which continues even in August, although the rains begin to cease in that month.

The weather becomes fair in September, and the air clear, with gentle South winds; and this continues till January, the hottest days being in December.

(69.) The Harmattan.—On the Gold Coast, as well as the windward coast an easterly wind, called the *Harmattan*, prevails during the months of December, January, and February. This wind comes on indiscriminately, at any hour of the day, at any time of the tide, at any period of the moon, and continues sometimes only a day or two, sometimes five or six days, and it has been known to last fifteen or sixteen days. There are generally three or four returns of it in every season; it blows with a moderate force, not quite so strong as the sea-breeze, which every day sets in, during the fair season, from the West, W.S.W., and S.W.; but somewhat stronger than the land-wind at night, from the North and N.N.W. In the "Philosophical Transactions," vol. lxxi., for the year 1781, an account of the *Harmattan* was

first given by Matthew Dobson, M.D., F.R.S., from the enquiries and observations of Mr. Norris, of which the following is the substance:—

On that part of the coast of Africa which lies between Cape Verde and Cape Lopez, a singular periodical easterly wind, named, by the natives, *Harmattan*, prevails during the months of December, January, and February. Cape Lopez lies to the southward of the line. At the Isles de Los, which lie to the northward of Sierra Leone, this wind blows from the S S.E; on the Gold Coast, from the N.E.; and at Cape Lopez and the River Gaboon, from the N.N.E.

The Harmattan comes on as above described. A fog or haze always accompanies it, and the gloom is sometimes so great as to render near objects obscure. The sun is thus concealed the greatest part of the day, and appears only a few hours about noon, and then of a mild red colour. At 2 or 3 miles from shore the fog is not so thick as on the beach; and at 4 or 5 leagues distance it is entirely lost, though the Harmattan is felt for 10 or 12 leagues, and blows fresh enough to alter the course of the current.

Extreme dryness is a property of this wind. No dew falls during its continuance, nor is there the least appearance of moisture in the atmosphere. All vegetables are much injured, and many destroyed. The seams in the sides and decks of ships become very leaky, though the planks are 2 to 3 inches thick. Iron-bound casks require the hoops to be frequently driven tighter, and a cask of rum or brandy can scarcely be preserved; for, unless kept constantly moistened, the hoops fly off. The Harmattan has, likewise, very disagreeable effects on the skin, lips, and nose, which become sore.

The effects of the Harmattan in evaporation are great, as will appear by the following comparative statement:—At Liverpool, the annual evaporation is about 36 inches; at Whydah, 64 inches; but, under the influence of the Harmattan, at the rate of 133 inches.

The wind, though so prejudicial to vegetable life, is highly conducive to health; so that fluxes, fevers, small-pox, &c., generally disappear in spite of the doctor; and it contributes to the cure of ulcers, and cutaneous eruptions. The baneful effects which have been said to arise from the prevalence of this wind proceed from the periodical rains, which fall in March, April, &c, and are ushered in by the tornadoes from the N.E. and E.N.E., accompanied with violent thunder and lightning, and very heavy showers. The earth, drenched by these showers, and acted upon by an intense solar heat, so soon as the storm is over, sends forth such noisome vapours as are the occasion of putrid fevers and other diseases.

On this coast, from the middle of February to the first week in March, a wind up the coast, from S.S.W. to S.S.E., prevails for about three weeks. The tornado season is part of March, all April, and the greater part of May, about twelve weeks. The rainy season is from the latter end of May, all June, and to about the 20th of July, about eight weeks. Hence, high wind, and squally, with very heavy rains, to the middle of August, about three weeks. The rain ceases; and then, for the first three weeks in September, the weather is foggy and close, without any breeze. From this time, for about six weeks, the wind blows fresh down the coast; the tornadoes and southerly wind then succeed, with some rain, generally called the *latter rains*,

about four weeks, to the beginning af December, when the Harmattan season commences.

(70.) *Remarks by Baron Roussin.— Cape Bajad·r to the Isles de Los.*—On the whole extent of the African coast there are but two seasons, namely, the *rainy and dry seasons.* The division of the two is connected with the periods when the sun crosses from one hemisphere to the other, and is modified as he advances to, or recedes from, the Equator.

The *rainy season* commences at each place on the coast to the northward of the Equator, at the time when the sun passes the zenith of that place in his course to the northward. It is, usually, during the month preceding this event that the change of weather takes place. It may therefore be calculated that, at the Isles de Los, the first point exposed to the rainy season, and which lie in 9½° N., the first violent squalls do not occur before the 10th or 15th of May. Their arrival seems to be affected by the moon; for they almost always commence, and are most violent, on the days of the new and full.

The rainy season ends in very violent squalls, with intervals of calm, of which there are at least two, and frequently more, during the twenty-four hours; and we remarked that they generally happen on the rising or setting of the sun or moon. In the country, these squalls are generally called *tornadoes;* but, according to the best information, the tornado, properly speaking, is to be met with only to the southward of Cape Verga. They generally begin to form themselves in the N.E. or E.N.E. quarter of the horizon, which seems completely on fire during an hour or more. The storm then gradually shifts round to East and E.S.E., becoming darker in the horizon. Having arrived at S.E., it attains its full vigour, when thunder and lightning become incessant. A moment of absolute calm then takes place, which is caused by the obstruction which the usual winds from the N.W. meet with from this immense mass of clouds. Shortly after, a small arch is formed at the horizon, which increases and rises rapidly. The more defined the edge of this arch appears, the more violent will be the storm, as it is a proof that the column of air has divided much heavier clouds, and is more confined. When the summit of this arch has attained an altitude of about 45°, the hurricane bursts forth, and torrents of rain immediately follow. The crisis of its greatest violence generally lasts from 15′ to 20′; it afterwards gradually becomes weaker; and finally nothing remains but rain, attended with very little wind. It then shifts round from S.E. to W.S.W., then to the quarter from which the usual winds blow, to exhaust itself to the northward in another squall from the S.E.

The *rainy season,* at any place, continues from four to six months, according to its proximity to the Equator, and the tornadoes continue to decrease, both in frequency and violence, during the two latter months of the season. In ten days or a fortnight after the sun has passed the zenith of any place on his way to the South, it is considered as free from bad weather. On the 15th of November a gun is fired at Goree, which announces the return of the fine season.

The squalls here spoken of, and the winds which precede or follow them, generally occupying so very small a portion of the year, may be considered

as momentary convulsions in a state of climate almost unchangeable; a sky nearly always serene, and generally clear.

On the greater part of the African coast, from Cape Bojador to the Isles do Los, regular winds blow, and no rain ever falls during eight months. The prevailing winds in this country blow from N.E. to N.W.; it may, therefore, be said that they follow the direction of the coast from North to South, and that they seldom vary from the limits here assigned.

The *dry season* commences in the latter part of October at Senegal; a little later at Goree; and at each intermediate place toward the Equator it becomes gradually later. It is not till the beginning of December that its return is observed in the parallel of the Isles do Los.

(71.) *Remarks on the Harmattan, by Baron Roussin.*—Although the winds from N.E. to N.W. prevail on the N.W. coast of Africa during the dry season, that is, from November to May, they are, nevertheless, occasionally interrupted between the 1st of December and the 1st of February by the land-wind, which blows from E.N.E. to E.S.E., and sometimes with violence.

It is this wind which the inhabitants of the country call the Harmattan It comes on at different periods in the above interval, and blows during one, two, and sometimes five or six successive days. This continuance, however, is rare, as it is generally interrupted by the sea-breezes, which commence about noon, after a calm of one or two hours. These alternate land and sea-breezes generally last till the end of February, when the usual winds entirely prevail. The Harmattan, which passes over the most arid country of the globe, is of an extremely dry nature, and would probably become insupportable, were it not frequently allayed by the sea-breezes above mentioned. Notwithstanding the salutary effect of these breezes, the drought is astonishing, so long as the Harmattan lasts. Mankind are inconvenienced; vegetables suffer so much as to be nearly killed; the sun loses its brilliancy, and is only to be seen when near noon; the sand, brought with it from the desert, pervades the atmosphere, and prevents objects from being distinguished at the distance of a quarter of a mile. Nevertheless, the effect of the Harmattan is not really injurious to health; it is remarked that it even purifies the atmosphere, by destroying the noxious vapours with which it is replete on the conclusion of the rainy season. It is usually on the return of the Harmattan that recovery commences from disorders which are incident to the climate.

The fog which accompanies the Harmattan loses nothing of its density when 3 leagues out at sea. On the edge of the Bank of Arguin, which is 10 leagues from the land, it prevented our distinguishing the horizon during three successive days. This state of the atmosphere is not permanent, but varies with the winds which produce it; and, in general, independent of the Harmattan, the African coast, from Cape Bojador to Cape Verde, is continually covered, during the whole dry season, with a white mist, which is seen from the sea much sooner than the land, of which it is a sure indication. This mist, which is nothing but sand, the extreme fineness of which allows of its being supported by the least agitated air, is particularly remarkable on that part of the desert between the parallel of 22° and Senegal. We have seen it at the distance of 5 leagues, when the coast could scarcely be

seen at 3 leagues. This dust, alluded to on page 175, is further remarked on at the end of this volume.

(72.) *Remarks by Capt. T. Boteler, of H.M.S. Hecla.*—The *Harmattan Season* sets in with November, or about a month earlier than off the Gambia, and prevails through December and part of January, but not quite constantly; for occasional intervals of clear weather, accompanied by the refreshing sea-breezes from the N.W., sometimes afford a respite to its oppressive effects. Nor does the Harmattan blow uniformly, either in the same direction, or with the same strength; for it ranges through eight points of the compass, from N.N.E. to E.S.E.; and, however fiery at the commencement, declines, after the first month, to a comparatively light breeze.

The *peculiar haze*, which more or less envelopes the coast of Africa at all times, is at its maximum during the influence of the Harmattan; and, though partially dispersed by the tornadoes and the rainy season, returns with increased density when they cease. Strangers should, therefore, be on their guard when estimating their distance from the land, as the deceptive effect of this haze makes it appear much further off than it really is; for the contrast which the coast presents to the eye, in different states of the atmosphere, is very great. In clear weather the view of the fertile shelving hills in the Isles de Los, the stupendous features of the distant mountains, the plains covered with trees, and the beautiful little island of Matacong (described hereafter), are highly interesting; while, in hazy weather, nothing is visible but a low mangrove coast, enveloped in mist, with an indistinct opening of a river here or there, or perhaps a column of smoke rising from a native village.

The *rainy season* continues for four months, from May to September; but the *tornadoes*, which invariably accompany its commencement and termination, generally cease between those periods. They blow from the E.S.E., and with great fury; but they seldom last more than three hours. The prevalent winds, during the rest of the rainy season, are from the southward and westward, and are usually so light as to give way in the afternoon to the N.W. sea-breeze.

6.—WINDS AND CALMS ON THE TROPIC.

(73.) Between the N.E. trades, and the westerly winds which prevail more or less to the northward of them, there is a belt of variable and light winds, which have, perhaps somewhat vaguely, been called the *Calms of Cancer*—a term which will not express its characteristics.

It is called, also, the *Horse Latitudes*, from the fact that vessels in former years, employed in carrying horses to the West Indies, were frequently obliged to throw them overboard during the embarrassment caused by the continual changes, sudden gusts and calms, rains, thunder and lightning, which are general in it (19), page 182.

(74.) This zone is caused by the uniting, or interchanging, of those upper but contrary currents which pass northwards over the N.E. trades in consequence of the heat acquired under the tropical sun having reached the northern extreme of this superheating influence. They here meet the currents passing southwards to feed the trades from the polar regions, and thus pressing against them cause the high barometer peculiar to this belt, standing as it does at a higher level than either to the North or South of it. Captain Maury infers that the mean height of the mercury in this belt is 30·21 inches, and at the Equator at 29·93 inches. Admiral FitzRoy states the mean height of the barometer in the latitude of England to be 29·95′. This greater height of the mercury, showing increased pressure, will be an index to the sailors that he has reached this intervening belt between the passage and trade winds.

From the lower part of this zone pass out two currents of air, one to feed the N.E. trades, as before described, and the other to form the anti-trades or passage winds; and it is fed by the polar and tropical counter currents which flow over these different wind systems.

(75.) The mean latitude of this belt is from 30° to 35° N., but varying with the motion of the sun in the ecliptic, as explained in (38), page 197. In fact, the northern edge of the trade wind may be taken as the axis over which this belt moves, sometimes of great breadth, as 10°; at others not felt at all. The mean position of these tropical calms, &c., will be best comprehended by an inspection of the diagrams. As is well known, this belt is the line upon which the dreaded cyclones turn; they pass to the W.N.W., to the South of it; and to the E.N.E., to the North of it; showing the origin of the struggle between the polar and tropical currents, which is evident in their tremendous phenomena.

(76.) As was said in (38), page 197, the range over which the northern limits of the N.E. trade is met with, seems to be, from Maury's chart, about 10°; but as this chart is apparently not quite perfect, or, at least is not derived from sufficient data to pronounce absolutely upon, it may be said that the mean position of the tropical calms in the various seasons of the year cannot with certainty be predicted; but as it does not offer the same obstacles to navigation as those of the equatorial regions, it is of less importance to the sailor, who, by his usual sagacity and prudence, may guard against the squalls, thunder-storms, and calms, which characterize it.

(77.) To the westward of the meridian 50° W.—that is, the western half of the N.E. trade in the North Atlantic—the trade is very light during the months of September and October; perhaps at other times of the summer and autumn. They will be most felt between the parallels of 15° and 25°; but not with any certainty near the American coast. This region may therefore be added to the tropical calms during these months.

As examples of the winds, as observed upon the lands lying in this belt, we select the remarks upon the Bermudas:—

(78.) Bermudas,—The winter, or cold season, at Bermudas, is the most agreeable, and lasts from November to March, the mean temperature being 60°; the predominant winds are then from the westward; if to the northward of this, fine, hard weather, with a clear sky, accompanies them. This is the favourable time for refitting ship, painting, &c. The close of this is

NORTH

Diagrams illustrating the directions of

ANTI-TRADES OR PASSAGE WINDS.

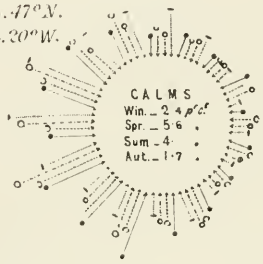
WEST

EAST

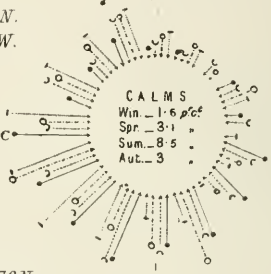
Lat. 47° N.
Lon. 10° W.

Lat. 52° N.
Lon. 15° W.

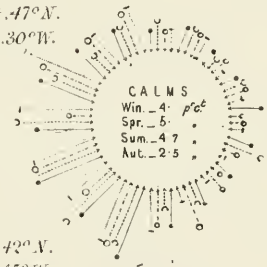
Lat. 47° N.
Lon. 20° W.



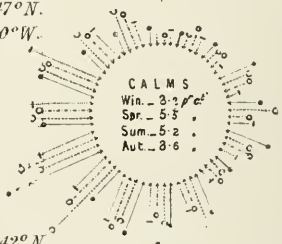
Lat. 52° N.
Lon. 25° W.



Lat. 47° N.
Lon. 30° W.

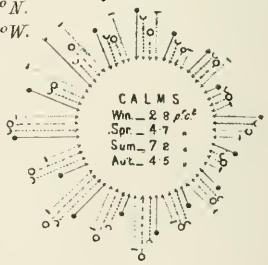


Lat. 47° N.
Lon. 40° W.



Lat. 42° N.
Lon. 45° W.

Lat. 42° N.
Lon. 65° W.



The arrows represent winds blowing toward the centre

Winter (Jan. Feb. Mar.) ····· *Spring* (Apr. May June) o ····· *Summer* (July Aug. Sep.) ——— *Autumn* (Oct. Nov Dec.)

The length of the arrows is proportionate to the frequency of that wind, and the proportion per cent will be given by this scale.

5 10 20 30 40 50 60 70 80 90 100

SOUTH

Pub. Murie, London.

often a very fine, bright day, with little wind and partial calms, when the wind is certain of going round to the S.W.; the weather becoming hazy, damp, subject to heavy rains and gales. The thermometer immediately attains 60° to 70°. These alternate north-westerly and south-westerly winds prevail through nine months of the year, the wind remaining at no other point for any length of time. This change is exhibited by a difference of 14° in the temperature. At this season it seems advisable for ships bound to the southward to wait and take the first set-in of the north-westerly winds. In most cases, it will ensure a quick run to the variables, and often to the trades.—*Mr. H. Davy.*

In the latter part of February spring commences, and the weather usually continues mild, with refreshing showers of rain and gentle breezes from the South and West, until the end of May. In June the summer sets in, and the weather becomes hot. Calms now succeed to the gentle breezes of May; the air is sultry and oppressive, and long droughts are common, which are often broken up by heavy thunder-storms. In September the weather changes its character, and becomes again mild and agreeable.

The dew-point in Bermuda usually ranges high. The climate being therefore moist, is favourable to vegetation at all seasons, except during the droughts of summer, and the storms of winter.

Hurricanes and tempests are very frequent, as is to be expected from the proximity of the isles to the variable limit of the trade and other prevailing winds. Few autumns pass without hurricanes of more or less violence.

The *Bermuda Squalls* are sudden and violent tempests, occurring particularly in the winter season.

According to the observations registered at Her Majesty's Dockyard, in 1853-4, the easterly winds, or those to the East of North or South, prevailed for a mean of 139 days, and westerly winds for 186 days; the remainder being made up of calms and variable winds.

7.—THE ANTI-TRADES OR PASSAGE WINDS.

(79.) In a previous page, 182 (19), the reason is given for applying the term *Anti-Trades* to the variable, but westerly, winds which prevail to the northward of the Tropic of Cancer. In the consideration of these winds, which only extend over an area, compared to that of the trade winds, as 5 is to 12 (thus showing their vastly inferior importance in the atmospheric economy), it will be found that it is impossible to accurately define their direction and character at any particular season. The great difference which exists between the winds and seasons of different years, which, however, when combined with a series, show a well-marked and consistent average, will demonstrate that it is only the doctrine of chances which can determine whether a single ship will encounter a particular wind at a particular time and place. Therefore this section will be less definite in its teachings than that on the trade winds.

(80.) There is one fact which modern meteorological study has established, and that is the frequent progress of storms in an easterly or north-easterly direction across the Atlantic, in the regions of the anti-trades. This will be alluded to hereafter (90) (91), together with the rotatory nature of such storms.

(81.) The most accurate and extensive observations—extensive because continuous—which have been made upon the direction and force of the wind in these latitudes, are those made upon *land*, and especially by self-registering. instruments, which have been in operation for a series of years, and give absolutely the quantity and path of the wind passing over the observatory during their operation. But, as will be shown presently, these observations, however excellent, are fallacious; they do not give the *correct* normal direction of the wind, but that of the wind under the powerful influence of the adjacent land and its configurations. In future years this may be obviated by the erection of these anemometers on isolated spots, as has been done at Bermuda, or any other position distant from any great mass of land.*

(82.) The *westerly* predominance of anti-trades will be more manifest from an examination of the quantity (or force) of the winds, rather than its prevalence, from those quarters; so that mere *numerical* preponderance gives an imperfect notion of the real proportion of westerly or easterly winds. Thus, as has been before remarked on page 198, the Pilot Charts of Capt. Maury, though the result of vast labour and of the first importance as one grand repertory of facts, are deficient in this respect. A perfect Wind Chart is yet to be constructed.

(83.) But there have been numerous analyses of these wind charts, combined with observations derived from other sources. We need not further allude to the series of wind charts drawn up from Captain Maury's numerical data by Admiral FitzRoy, nor of those arranged by the Netherlands Meteorological Institute at Utrecht. But there is one essay which is of much importance, which was published by the Hamburg Meteorological Office (Norddeutsche Seewarte), and has been translated by our own Meteorological Department, in 1872. It was drawn up by H. von W. von Freeden, Director of that Office,† and is entitled, "On the Winds, &c., of the North Atlantic, along the tracks (and from the logs) of North German Lloyds steamers," between the Channel and New York.

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* On page 178 (12), the question of force, as encountered by ships in *motion*, is alluded to as not giving a correct estimate, as it ought to be the real amount without the effect of the ship's driving before it. The land observations also are modified by the above-mentioned influence. A plan has been proposed by Professor Piazzi Smith, in conjunction with Capt. H. Toynbee, to have the wind recorded from the *mast-head*, as the only part of a ship not affected by the eddies from her sails; the direction and force to be communicated electrically to the cabin and there recorded. See "Report of the British Association, 1855," page 45.

† Translated from No. III. of the Mittheilungen aus der Norddeutschen Seewarte, Ueber die Dampferwege zwischen dem Kanal und New York, nach den Journal-Auszügen der Dampfer des Norddeutschen Lloyd, in den Jahren 1860-67. Nebst Wind und Wetter in derselben Zeit. Von W. von Freeden, Director.

(84.) We extract the following from the work, premising that the charts referred to have not been copied here.

THE WINDS OF THE NORTH ATLANTIC BETWEEN 55° AND 40° N. LATITUDE.

We have made two wind charts, of which the first, constructed according to the old system of Maury, contains the aggregate number of observations collected by Maury, Andrau, and the Norddeutsche Seewarte (the Hamburg Meteorological Office), amounting to 55,710 observations, including calms and variables. The second chart exhibits, partly numerically and partly graphically, 16,653 observations, made specially in the routes of the North German Lloyd steamers. From the detailed information given in these charts it is proposed to condense the masses of figures into closer groups, and to elucidate the relative frequency of occurrence of any wind by means of per-centages. In the first place we give—

A.—GENERAL WIND TABLE *for the North Atlantic, between lat.* 55°—40°, *in the Yearly Period, and referred to Eight Points of the Compass.*

Long. W.	Lat. N.	No. of Observations.	Variable.	Calm.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
° °	° °											
	55—50	4,244	45	140	250	364	443	558	712	828	562	322
5—35			1 *p. c.*	3 *p. c.*	6 *p. c.*	9 *p. c.*	10 *p. c.*	13 *p. c.*	17 *p. c.*	20 *p. c.*	13 *p. c.*	8 *p. c.*
	50—45	25,454	134	1,078	2,328	2,495	2,283	2,906	3,909	4,220	3,650	2,451
			1 *p. c.*	4 *p. c.*	9 *p. c.*	10 *p. c.*	9 *p. c.*	11 *p. c.*	15 *p. c.*	17 *p. c.*	14 *p. c.*	10 *p. c.*
	,,	5,384	86	187	337	379	302	622	917	1,067	864	623
35—55			2 *p. c.*	3 *p. c.*	6 *p. c.*	7 *p. c.*	6 *p. c.*	11 *p. c.*	17 *p. c.*	20 *p. c.*	16 *p. c.*	12 *p.*
	45—40	8,007	54	376	611	583	721	1,047	1,284	1,399	1,082	850
			1 *p. c.*	5 *p. c.*	8 *p. c.*	7 *p. c.*	9 *p. c.*	13 *p. c.*	16 *p. c.*	17 *p. c.*	13 *p. c.*	11 *p. c.*
55—74	,,	12,641	180	555	1,093	1,124	914	1,550	1,900	2,221	1,744	1,360
			1 *p. c.*	4 *p. c.*	9 *p. c.*	9 *p. c.*	7 *p. c.*	12 *p. c.*	15 *p. c.*	18 *p. c.*	14 *p. c.*	11 *p. c.*
Total - -		55,730	499	2,336	4,619	4,945	4,663	6,683	8,722	9,735	7,902	5,606
			1 *p. c.*	4 *p. c.*	8 *p. c.*	9 *p. c.*	8 *p. c.*	12 *p. c.*	16 *p. c.*	18 *p. c.*	14 *p. c.*	10 *p. c.*

By adding one-half the intermediate points to each of the four adjacent cardinal points (W. = W. | ½ S.W. + ½ N.W.), we find that—

Westerly winds are	33	per cent.
Southerly ,,	23	,,
Northerly ,,	22	,,
Easterly ,,	17	,,
Calms and variables	5	,,

The westerly to northerly winds are more certain to be found between 35° and 55° W. in higher latitudes, whilst the S. to S.E. winds will be met with

more frequently in the lower latitudes, below 45° N. Easterly winds are always more prevalent in lower latitudes, corresponding to the preponderance of the westerly winds in high latitudes.

The distribution in the separate months of the year, and in seasonal quarters, will lead to practically useful results. The following table shows:—

B.—General Wind Table *of the North Atlantic, between* 55° *and* 40° *N. latitude, for separate Quarters, and the Eight principal Points, in per-centages of the Wind's frequency.*

Quarter.	Long. W.	Lat. N.	No. of Observations.	Variable.	Calm.	NE. p. c.	E. p. c.	S.E. p. c.	S. p. c.	S.W. p. c.	W. p. c.	N.W. p. c.	N. p. c.
	° °	° °											
Winter. 10,067 observations.	5—35	55—50	946	—	.2	5	7	9	16	18	22	13	8
		50—45	4,886	1	3	8	9	10	14	18	17	12	8
	35—55	50—45	952	2	2	6	7	7	12	14	20	17	13
		45—40	1,241	1	3	8	6	8	12	15	19	16	12
	55—74	45—40	2,042	1	2	8	8	5	9	10	.19	24	14
Spring. 14,922 observations.	5—35	55—50	905	—	3	7	12	15	15	14	15	11	8
		50—45	7,414	—	4	11	12	11	11	14	15	12	10
	35—55	50—45	1,042	—	3	8	8	6	10	16	18	18	13
		45—40	2,355	1	5	8	5	8	12	16	17	16	12
	55—74	45—40	3,203	1	4	10	10	8	12	13	16	14	12
Summer. 17,377 observations.	5—35	55—50	1,340	—	5	5	6	8	13	19	21	15	8
		50—45	7,071	—	6	8	7	6	9	17	20	17	10
	35—55	50—45	1,787	2	5	5	7	5	13	21	22	12	8
		45—40	2,770	—	6	6	8	10	16	18	20	9	7
	55—74	45—40	4,409	2	6	6	9	9	15	21	17	8	7
Autumn. 13,344 observations.	5—35	55—50	1,033	2	2	6	9	11	10	18	20	15	7
		50—45	6,083	—	4	8	11	11	12	14	15	15	10
	35—55	50—45	1,603	2	3	8	6	5	12	15	19	17	13
		45—40	1,641	1	5	10	9	10	11	12	13	16	13
	55—74	45—40	2,984	1	4	10	8	6	10	12	18	17	14

If we compare—

A. The distribution of the winds *across the entire ocean*, in the yearly and quarterly periods, we see that the per-centages of the wind's frequency vary very much. If the differences of the per-centages, as compared with the mean yearly values, are expressed by numbers five times too great, and if we indicate by — when the quarterly number is smaller, and by + when it is larger than the yearly number, we get (reckoning right across the ocean):—

Quarter.	Variables.	Calms.	N.E.	E.	S.E	S.	S.W.	W.	N.W.	N.
Winter	−1	−7	−3	−5	−2	+3	− 5	+ 5	+12	+ 3
Spring.....	−4	0	+6	+5	+7	0	− 7	−11	+ 1	+ 3
Summer	−2	+9	−8	−5	−3	+6	+16	+ 8	− 9	−12
Autumn	0	−1	+4	+1	+2	−5	− 9	− 7	+10	+ 5

We perceive with remarkable clearness the double period of the decrease of the N.E. to S.E. winds in winter and summer, in contrast to an increase of the S. to N.W. winds in the same seasons, and conversely an increase of N.E. to S.E. winds in spring and autumn, and a less frequent occurrence of the S. to W. winds at the same time. The reason why the N.W. and N. winds are proportionally less frequent in summer may be because the region of average uniform heating of the oceanic atmosphere then extends beyond 55° N., whilst in all other seasons the limit falls down to 50° N., and so gives the cold polar wind an opportunity of breaking into the warmer equatorial current at, or to the South of, 50° N. But if we look at the distribution of the N.W. and N. winds in separate meridional strips, we find them decidedly more frequent in the eastern parts of the ocean, as far as 35° W. in summer (23 *p.c.** against 21 *p.c.* ; 27 *p.c.* against 24 *p.c.*); on the contrary, in the western parts, as far as 74° W., the occur much less often (16 *p.c.* against 24 *p.c.*; 15 *p.c.* against 25 *p.c.*). Here the summer heating of the European as well as the American continent evidently exerts its influence, and it attracts the cold N.W. wind of the ocean towards the European coasts lying from S.W. to N.E.; whilt for the same reason it diminishes the frequency of this wind on the American coast, and, on the other hand, must increase the S.E. and S. winds (the tables give 24 *p.c.* against 19 *p.c.*) These explanations as to the causes of the prevailing summer winds on our coasts are here explained by unequivocal numerical values.

B. An enquiry into the distribution of the winds *with reference to longitude only*, seems still called for from our special considerations.

Our general wind table gives the following mean values of the wind's frequency; the per-centages are now doubled:—

Longitude.	Variables.	Calms.	N.E.	E.	S E.	S.	S.W.	W.	N.W.	N.
Between 5°-35° W.	2	7	15	19	19	24	32	37	27	18
„ 35°-55° W.	3	8	14	14	15	24	33	37	29	23
„ 55°-74° W.	2	8	18	18	14	24	30	36	28	22

From which it at once appears that between 35° and 55° W., that is, in the middle of the North Atlantic Ocean, the easterly winds throughout are less frequent than in the districts bordering it to the East and West, that the South winds are equally numerous in all three districts, the remaining winds, between S.W. and N., are decidedly more frequent in the central trip than to the West and East of it.

But if we again compare the per-centages of the same longitudinal sections in the year with the separate quarters, and keep to the above notation, we obtain—

* These figures are obtained by comparing the results for the summer, in Table B, page 234, with those for the year, in Table A, page 233.

1. Between 5° and 35° W., in doubled per-centages.

Quarter.	Variables.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	−1	−2	−2	−3	0	+6	+4	+2	−2	−2
Spring.....	−2	0	+3	+5	+7	+2	−4	−7	−4	0
Summer	−2	+4	−2	−6	−5	−2	+4	+4	+5	0
Autumn	0	−1	−1	+1	+3	−2	0	−2	+3	−1

In the eastern parts of the Atlantic, therefore, the distribution of the winds in autumn agrees for the most part with the yearly mean, whilst the absolute differences are greatest in spring and summer. In winter and summer we find fewer East winds, but more westerly winds, than in the yearly mean; but S.W. and N.W. winds are more especially prevalent in summer than in the year generally, and the preponderance of the N.W. winds still continues in autumn. On the other hand, we find in spring a strong set of cold easterly, *i.e.*, continental winds from the Steppes towards the ocean, and the S.W. to N.W. winds must give way to them. This is a detailed confirmation of our above generalizations as to the causes of the N.W. winds in summer. If the sea gets thoroughly warmed in summer we then have frequent calms near the channel.

2. Between 35° and 55° W., in doubled per-centages.

Quarter.	Variables.	Calms.	N.E.	E.	S.E	S.	S.W.	W.	N.W.	N.
Winter	0	−3	0	−1	0	0	−4	+2	+4	+2
Spring.....	−2	0	+2	−1	−1	−2	−1	−2	+5	+2
Summer	−1	+3	−3	+1	0	+5	+6	+5	−8	−8
Autumn	0	0	+4	+1	0	−1	−6	−5	+4	+3

The small numerical differences in winter and spring are very striking, whilst in summer they are exceedingly high, and in autumn moderate; on the whole, however, they are smaller than between 5° and 35° W. The change of the sign is about the same as before, but it is to be remarked that in summer the N.W. and N. winds are, relatively, extremely rare, compared with the S. to W. winds, whilst in autumn exactly the reverse takes place. The prevalence of easterly winds in spring and autumn, which was exhibited between 5° and 35° W., is no longer traceable; these winds have exhausted themselves, *i.e.*, generally speaking (for, *e.g.*, in February, 1870, our steamers encountered, in 48° W., the East wind which had come from 60° E., and brought the most severe winter cold over central Germany, which was, by the way, a propagation in a straight line of an easterly gale, which the advocates of the cyclone theory have not yet explained); at the best the N.E. only occurs somewhat frequently in conjunction with N.W. and N., evidently in the closest connection with the decreasing northern declination of the sun.

3. Between 55° and 74° W., in doubled per-centages.

Quarter.	Variables.	Calms.	N.E.	E.	S.E	S.	S.W.	W.	N.W.	N.
Winter	0	−4	−2	−2	−4	−6	−10	+2	+20	+6
Spring.....	0	0	+2	+2	+2	0	− 4	−4	0	+2
Summer	+2	+4	− 6	0	+4	+6	+12	−2	−12	−8
Autumn	0	0	+2	−2	−2	−4	− 6	0	+ 6	+6

That the characteristics of summer and winter vary greatly from the yearly mean is seen immediately, and at the same time the almost complete discontinuance of the symmetry in the variation of the wind numbers in winter and summer on the one hand, as compared with spring and summer on the other. Certainly the easterly winds fall short in winter, but with them also the southerly and south-westerly, and, in their stead, the powerful winds from N.W. and N. prevail, which are known to sailors as the dreaded snow storms. In spring, if the sea cannot rise in temperature as soon as the flat American continent, owing to the flow of ice over the Banks of Newfoundland, the N.E. to S.E. winds blow on to the land; in summer, the cool S.E. to S.W. winds prevail on the American coast, blowing from the cool sea on to the land, which has been raised to Italian heat, until, at length, in autumn, the cold N.W. wind accompanies the sudden transition to winter. As, in summer, with the increasing northern declination of the sun, the Gulf Stream also advances some degrees to the northward; calms are not rare, owing to the greater equality of temperature between land and sea.

The task now remains to us—after having investigated the distribution of the winds, so important for general climatology, according to longitude—to prove whether, for the practical purposes of navigation (and we always keep in view the interest of sailing vessels as well as steamers):—

C. The distribution of the winds *according to latitude and longitude* leads to results which are worth notice.

The question now presents itself whether a ship, in any certain season of the year, should keep a decidedly or partially northern or southern course from and to America, and what she should do in any certain position if overtaken by contrary wind or gale.

We have only to deal with the general question what answer should be made for the separate *quarters* of the year. With this object we shall investigate for each longitudinal section the simple per-centages of the winds to the North and South of the latitudes under consideration. If the Southern zone has a less per-centage than the Northern we shall denote the same by the sign −, and the converse by the sign +.

1. Between 5° and 35° W., in doubled per-centages.

Quarter.	Variables.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	+2	2	+6	+4	+2	−4	0	−10	−2	0
Spring.....	0	+2	+8	0	−8	−8	0	0	+2	+4
Summer	0	+2	+6	+2	−4	−8	−4	− 2	+4	+4
Autumn	−4	+4	+4	+4	0	+4	−8	−10	0	+6

The differences increase steadily from winter and spring until autumn, otherwise they are pretty equal. Therefore, in winter, we have to expect more easterly winds to the South of 50° N., and fewer S. to N.W. winds, than to the northward of 50° N.; in spring, the N.W. to N.E. winds prevail to the South of 50° N., while the S.E. and S. winds greatly decrease; also in summer, where the S.E. to W. winds are in the minority, and the same in autumn, where to the South of 50° N. the N. to N.E. winds and S. winds are in the minority.

Accordingly, on an average, outward-bound vessels would do better to keep to the southward of latitude 50° N., and homeward-bound ships would mostly stand a better chance to the northward of 50° N. Of course we exclude the special conditions of each month, which may be worked out in the same manner as the above results for seasons.

2. Between 35° and 55° W.

Quarter.	Variables.	Calms.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
Winter	−2	+2	+4	−2	+ 2	0	+2	− 2	−2	−2
Spring.....	+2	+4	−0	−6	+ 4	+4	0	− 2	−4	−2
Autumn	−4	+2	+2	+2	+10	+6	−6	− 4	−6	−2
Summer	−2	+1	+4	+6	+10	−2	−6	−12	−2	0

In this strip the differences increase considerably until autumn; in all the seasons we find fewer W. to N.W. winds to the S. of 45° N. than to the N. of it, so that a ship desirous of avoiding inconvenience from S. to S.W. winds, has only to hold off to the northward in order to continue her outward course on the starboard tack with success. In summer and autumn especially we find more N.E. to S.E. winds to the South of 45° N. than to the North of it, but of course it must not be forgotten that the absolute frequency of easterly winds is generally less than the westerly

(85.) Captain H. Toynbee, the Marine Superintendent of the Meteorological Department of the Board of Trade, has made a rigid examination of a very important series of logs, kept by Captain J. A. Martyn, of the Royal Mail steamers' tracks between the Channel and New York.* There are eight of these logs, and for each of them a separate diagram has been made (which cannot be given here), exhibiting the character of wind, weather, barometric pressure, air and sea surface, temperature, the specific gravity of the sea water, and the readings of the dry and wet bulb thermometers. Being thus uniformly arranged, a series of important deductions is derived from their teachings by Captain Toynbee, which bear out in a remarkable degree the observations previously made by Sir John Herschel and Mr. Birt on *barometric waves* (see (27) to (28), pp. 186—188 ante).

* "Report on the Meteorology of the North Atlantic, between the parallels of 40° and 50° N." by Captain Henry Toynbee, 1869.

(86.) Capt. Toynbee remarks:—Having considered the eight diagrams, I propose giving a few more facts before drawing any conclusions.

First, these peculiar undulations in the barometric curves, accompanied by corresponding changes in the wind, weather, and temperature, are quite in accordance with the experience of seamen in corresponding southern latitudes; there, from the latitude of the Cape of Good Hope down to 55° S., a similar series of changes is experienced, the winds commencing at North and ending at West or S.W.; it will be borne in mind that in this case the South is the polar wind. There, also, ships running to the eastward seem to keep company with a westerly gale, so that the wind continues from the same quarter for days.

With the object of discovering the breadth of these belts of southerly wind accompanied by a decreasing pressure, and of westerly wind accompanied by a decreasing pressure, I have calculated the number of geographical miles which the ship steamed to pass through them, and find from seven of those on diagram I., that each belt occupied about 20 hours, and the ship steamed about 150 miles; also, that in diagram I, the westerly wind belts were about as broad as the southerly ones. Now, by referring to the homeward passages, it will be seen that the steamer often kept in the same wind for days together, and in some cases had a decreasing pressure with a north-westerly wind, and an increasing pressure with a southerly wind; it therefore seems probable that she then kept pace with the general motion of the gale to the eastward, and in fact sometimes outstripped it, so that we can hardly be wrong in estimating that these systems of winds were travelling to the eastward at least at a rate of about eight miles an hour; hence, on the outward passage, whilst the ship steamed 150 miles to the westward, the gale by a rough estimate may be said to have moved about 150 miles to the eastward, giving a breadth of about 300 miles for each of the westerly and southerly wind belts.

(87.) The accompanying quotation from a letter I received from Captain R. Inglis, Marine Superintendent to the Cunard line of steamers, contains the opinion of one who has had great experience in Atlantic weather. He thinks that the westerly winds of the Atlantic are caused by the meeting of two currents of air; whether he be right or not, his facts are very interesting. Writing from Liverpool, he says:—Between this country and New York is the route of which I have had most experience, and the locality in which we have the most interest here." . . . "Drawing a line N.E. from the Caribbean Sea clear of the coast of Florida, it would cut our track to New York between the meridians of 40° and 50° W.; this will be found to be the western limit of the great S.W. equatorial current; this current of air from the S.W. touching the earth is now brought into contact with the North wind flowing to the southward, and the steady flow of the two currents, upper and lower, is interrupted; the northerly current in the latitude I have named will then have a course from nearly due North, certainly not past N.N.E., the southerly current of air will be S.W., therefore, by coming into collision, an almost continuous westerly wind will blow between 40° W. and England." . . . .

"Having accepted this theory, I determined to put it to a practical test, when commanding the screw steamer *Alp*, in 1857. It so happened that

whilst making a passage from Havre to New York we fell in with a heavy gale of wind from the westward, and it occured to me that the wind being West I was in the line of contact, so that if my theory were correct, the more I steered to the northward the more the wind would norther. We were steering West, so I put the ship's head off to N.W., and set the fore and aft sails; the ship's way increased, and in twelve hours the wind hauled sufficiently to the northward to enable me to lay my course on the starboard tack; by attending to this we beat the *Africa*, one of our powerful mail boats, a whole day.

"Again, coming from New York, we often fall in with a S.W. gale, with the weather bright and clear; this will continue for one or two days, how long, depends upon the northing we are making; if the ship is going due East she may carry the S.W. wind right across the Atlantic; if she is making northing she will fall in with drizzling rain; when this occurs *look out*, for the wind will fly round to N.W. suddenly. This has become a saying with sailors navigating the Atlantic, and it is always so, for then the ship is approaching the line of contact; the S.W. wind being warm and laden with moisture is coming into contact with the cold North wind, condensation ensues, and rain is the consequence. After the shift to N.W. we have squalls of hail; finally, as the ship gets to the northward, the wind hauls to North, and we have fine clear weather.

"This, as a rule, is a true explanation of the steady gales we meet with in the Atlantic, which, in mid-ocean, last for six or seven days; but this is not always the form which these two currents take, very often we meet with rotary storms of small circumference; when steaming out to the westward we often meet with these circlets, if I may so name them; in them we have the wind from all points of the compass during the twenty-four hours, with rain and dirty weather, not blowing very hard, but still disagreeable; this may last three, four, or five days; now these rotary storms are all going on at a rapid rate to the eastward, and finally strike our coast; they are occasioned by the opposing current of air being of unequal force, and would naturally resolve themselves into the rotary form.

"It is a singular thing to note that this current of air very rarely touches the coast of Spain; the times in which they have a S.W. gale on the coast of Spain, South of Cape St. Vincent, during a year, might be counted on your fingers.

"On the contrary, I have no hesitation in saying that during eleven months of the year there is a strong northerly wind blowing down the coast of Spain and Portugal, and further the prevailing wind in the Mediterranean is from the North, and this is the way I account for the supply of air being kept up that is necessary to fill up the vacuum caused by the air ascending near the line.

"If this theory be true, it follows that the great object of gathering the data you wish our captains and others navigating the Atlantic to collect, will be to determine where the line of contact is at the different seasons; of course it will vary North or South according to the declination of the sun.

"It would be of immense benefit to us to know that, on the passage out, by keeping to the North we should ensure northerly winds, and that during

the homeward passage a more southerly course would keep our ships in a south-westerly wind."

(88.) It seems quite clear that the steady westerly winds spoken of by Captain Inglis were experienced during the passage home, whilst the quick changing circlets to which he alludes were met with on the outward passage, which facts are borne out by Captain Martin's log; and the natural conclusisn is that homeward the ship was *moving with* a wave or system of weather, whilst outward she met several such waves.

It is a curious coincidence that the spot which Captain Inglis speaks of as the western limit of the great south-westerly equatorial current of air is the position of the eastern edge of the first cold water met with on the outward passage, and where northerly disturbances seem to be very common in the wind.

The effect of the temperature of the surface water on the wind and weather seems to be a phenomena of universal occurrence; in the warm water on the eastern edge of the Agulhas Bank the wind is notoriously unsteady, insomuch that however fresh and fair the wind may have been to a ship coming from the eastward, she is almost sure to get baffling unsettled weather in this warm water, and the clouds have a more tropical doldrum appearance: whereas, in the patches of cold water in the southern hemisphere, hail squalls from the S.W. are common (see my paper on the specific gravity, temperature, snd currents of the seas passed through during five voyages from England to India, read before the Royal Geographical Society, May 8th, 1865), just as hail and snow storm from the N.W. are common in the cold water to the eastward of North America, and ships are said to run out of it into the warm water of the Gulf Stream to refit after a fight with a winter gale. In fact, over cold and warm water in close proximity, we have the same forces in operation as those which enable land and sea breezes to reverse the prevailing wind of the season; and if atmospheric pressure relatively increases over cold water, then, according to Buys-Ballot's law, there would be a tendency to northerly winds on the eastern edge of a patch of cold water in the northern hemisphere, whilst southerly winds would be more prevalent on its western edge, unless its effect be masked by greater influences.

The north-easterly direction taken by these waves would most likely be due to the existence of a lower pressure over the northern part of the Atlantic than over the land to the eastward of it; whereas the changes of wind from S. by W. to N.W. woul be due to the internal action of the waves as it sweeps along; a section of the wave would represent a kind of revolving motion in the air, with its lower edge pressing on the earth's surface, whilst its upper edge is well inclined towards the Pole.

Professor Buys-Ballot says:—It is certain that, if after an unfavourable condition of pressure a S.W. wind has set in, which has veered with stormy weather towards N.W., we find that generally a very unfavourable condition, and usually the greatest difference, will be observed next day, without being followed by fresh wind." May not this be because part of the north-westerly wind is a downward motion instead of its being horizontal?

I account for the fact that during Captain Martyn's outward passages he had a decreasing pressure with a southerly wind, and an increasing pressure

with a westerly and north-westerly wind, showing that he was meeting gales; whilst during his homeward passages he had the pressure and wind steady for days together, showing that he was either moving to the eastward about as fast as the gale, or steaming faster than the gale was moving, and had a decreasing pressure with a northerly wind, and an increasing pressure with a southerly wind, caused by his entering these systems of wind on the opposite side to what he did on the passage out.

1st. When a ship is bound to the westward, and meets the southerly wind on the eastern edge of one of these gales, can she bring about a more favourable wind by running to the North, or otherwise manœuvring, or must she undergo all its changes from S. by W. to W.N.W. or N.W. as it is sweeping by her to the eastward?

We are not without evidence leading to the supposition that there is a polar limit to these westerly gales; for instance, Buchan, in his "Handy Book of Meteorology," gives a table of the prevailing winds in January, which shows that Iceland has about an equal amount of wind from all directions, whilst the prevailing wind in Greenland is easterly, and in Newfoundland north-westerly. The Meteorological Journal of H.M.S. *Rattlesnake*, Captain Trollope, R.N., which is in this office, shows that when she was frozen up in Port Clarence, Behrings Straits, during the winter of 1853 and 1854, she experienced north-easterly winds for two-thirds of the time.

(89.) A few remarks on the other observations shall end this paper.

It will be noticed that from England to about 40° W. and 47° N. the surface temperature is very uniform; in diagrams 5 and 6 this uniform temperature extends further West; then in about 49° W. a patch of cold water generally exists, after which streaks of warm and cold water were met with. On reaching longitude 65° W. a sudden decrease took place in the temperature of the surface water, with water somewhat warmer further to the westward.

The specific gravity is a difficult observation to make on board ship when there is much motion. Captain Martin doubts that below his ship, but both he and Captain Watson are now paying special attention to the observations of temperature and specific gravity, so that future observations may modify the results. Still they frequently find the water warmer at 20 feet deep than at the surface, which, taken together with the fact that the cold water has the least specific gravity, makes it possible that the Gulf Stream passes under this cold water on its way to the north-eastward; so that a few temperatures at various depths taken in that part of the sea where the Gulf Stream seems to be cut off by the cold water might lead to interesting results. Captain Martin hopes to give the currents experienced on some of his future voyages.*

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* In Captain Watson's last log I find the following entry:—March 27th, 1869, position at noon, lat. 40° 42′ N., long. 63° 28′ W.

Noon,	surface temperature	67°;	specific gravity	1.0270.
2 p.m.	„	38°;	„	1.0260.
4 p.m.	„	38°;	„	
5 p.m.	„	52°;	„	1.0265.

(The ship was steaming to the eastward).

Here there were two sudden changes of temperature and specific gravity in a few hours.

The dry and damp bulbs show clearly that the W. and N.W. winds were generally the driest experienced during the eight passages, but there happened to have been very little easterly wind. There are some striking instances of extreme dryness in air which, having passed over cold, was then over warm water.

(90.) The report of the Director of the New York Meteorological Observatory for 1872 contains some interesting information respecting storms in the Atlantic. Charts are now constructed in the Observatory, illustrating the progress and direction of barometrical and thermometrical waves crossing the United States, and the influence exercised by them on the regions which they pass, and endeavours are made to trace from these data the progress of American storms across the Atlantic, and to predict the time of their arrival on the European coasts. For this purpose the registers at the New York Observatory are compared with those kept at Valentia and Falmouth, distant about 3,100 miles, and it has been thus found that there are many atmospheric waves which traverse the Atlantic, and that within certain limits the times of their passage can be pretty accurately predicted. "If, in the case of an easterly wind, which is travelling about 200 miles in 24 hours, the exact time be found by the lowest reading of the barometer, and the speed be ascertained for 24 hours before and after that time, the mean of of these two numbers will give the true rate of the storm in 24 hours. Thus, if 4,200 be divided by the number thus found, the result will be the number of days which the storm will take to cross from New York to Valentia or Falmouth." An actual example of the application of this rule is given, and is worth quoting:—"On the 4th of October, 1869, there occurred a low barometer at the New York Observatory at 1 p.m. In the 24 previous hours the wind had travelled 313 miles; and, in the 24 succeeding, it made 286 miles. The mean of these numbess is 299, by which, if 4,200 be divided, the result is 14 days for the passage of the storm across the Atlantic." This calculation was exactly right, for the storm arrived at Falmouth on the 18th of October. It is stated that, since the year 1869, the computations made respecting 86 atmospheric disturbances expected to cross the Atlantic failed in only three instances to give accurate results. At present the rules for calculating the velocity of storms are not definitely established; but if the experience of the next two or three years confirms the above theory, or affords the means of correcting it, there seems to be no doubt that ship-captains will soon be able to trust implicitly to these directions.

(91.) In a recent publication of the Meteorological Office,* the fact of storms travelling eastwards is very lucidly shown in the diagrams by the daily positions of the isobars, and in the remarks given hereafter on the winds of the British Isles, some further remarks will be found, showing that the progress of the main body of the air is to the north-eastward across the British Isles. That it occasionally travels to the south-westward is also

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The correction for temperature has not been applied to the specific gravity observations; it would have increased the difference between those of the warm and cold water.

* A discussion of the Meteorology of the part of the North Atlantic lying North of 30° N. for the eleven days ending 8th February, 1870, by Captain Henry Toynbee.

mentioned. The chart for each one of the 11 days embraces the observations of about 30 ships, together with those of many land stations. Captain Toynbee draws the following conclusions from the study of these charts.

1. As to the origin of the numerous gales experienced during the 11 days with which we have been dealing.

By referring to the charts it will be seen that almost invariably there was a northerly wind on the American coast, and a southerly wind at some distance to the eastward of that coast. This state of the wind, considered in connection with Buys Ballot's law (p. 184), requires that there should be a trough of low pressure between two high pressures. Buchan's* monthly charts of isobars, giving the mean pressure over the globe, show that the above is the case in the months of January and February. The January chart shows the isobar of 30·2 over the American land, and again over the sea just to the northward of the N.E. trades, and we know that between these high pressures the hot Gulf Stream flows, which may well be supposed to cause an unusually low pressure, for, other circumstances being the same, it is found that the barometer is lower over warm than over cold water. For instance, the meteorological data of the 10° square between the Equator and 10° N., and from 20° to 30° W., show that the lowest pressure exists over the hottest water (47). The conclusions derived from a study of the data for this region for January will be found in the Report of the Meteorological Committee of the Royal Society for 1871.

Bermuda seems to be peculiarly placed with regard to the winds of which we are speaking, for the observations given in the first number of the publications by this office, as well as those given by Buchan, together with others sent by General Lefroy, which are quoted in this paper, show that the island is subject to alternations of northerly and southerly winds in winter, whilst in summer scarcely any northerly wind is recorded.

The fact of this alternation between northerly and southerly winds in winter seems to show that the position of this area of low pressure may be variable, and that it may sometimes lie to the eastward, sometimes to the westward of the island.

When summer sets in, and an area of low pressure takes the place of the high pressure over the land, the element for a northerly wind is taken away, so that Bermuda and the American coast are subject to southerly winds.

It will be readily understood how this alternation of high and low barometer over the land in winter and summer accounts for the extremes of cold and heat experienced by the East Coast of America, whilst we on the eastern side of the Atlantic are, in accordance with Buys Ballot's law, subject to southerly winds in winter, the highest barometer being then to the eastward of us.

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* "The Mean Pressure of the Atmosphere of the Prevailing Winds over the Globe for the Months and for the Year." By A. Buchan, M.A., F.R.S.E. "Transactions of the Royal Society," Edinburgh, vol. xxv., 1869.

To return to our subject: if the trough of low pressure cannot be shown to change its position, we have strong proof that frequent collisions take place between the northerly and southerly winds which blow in its neighbourhood, causing eddies, and that these eddies pass over Bermuda on a north-easterly route, producing first a south-easterly and then a north-westerly wind. We are thus led to the conclusion that these gales are caused by a collision between opposing currents of air.

The few storms dealt with in this paper support the idea that most of the winter snow storms of the Coast of America are connected with these gales. Besides the trough of low pressure over the Gulf Stream to which we have allued, Buchan's charts show a larger area of depression in the neighbourhood of Iceland at this season of the year, which is related to the prevailing winds of winter. It is probable that this low pressure is frequently intensified by the areas of low pressure which travel towards it from the East Coast of America, and that these areas of low pressure, taken in conjunction with the very high pressures which generally exist over the land in winter, are the causes of our winter gales.

2. We will next consider the tracks of these gales. All the evidence gained by studdying the data for these 11 days shows that they move to the north-eastward, and probably at a mean rate of nearly 30 miles an hour.

To give a graphic representation of their progress, the last chart has been constructed; it contains reductions of the whole 14, placed under each other in the order of time. There it will be seen that the gale of the 30th of January was South of Halifax at 8 a.m., had advanced towards Newfoundland by 6 p.m., and was half across the Atlantic by 8 a.m. of the 31st, when it seemed to be lost in the normal area of low pressure over the centre of the Atlantic.

A similar gale appeared on the 2nd of February; it advanced to the north-eastward and was lost by the 4th. On the 4th a N.E. gale was blowing on the American coast, and a moderate S.E. wind in 32° N. and 51° W. Unfortunately there was a large space of sea in the south-western quarter of the chart without ships, so that we have not such clear evidence of the progress of this gale; still on the 5th we find a very heavy gale and remarkably low pressure in the middle of the Atlantic, with a heavy N.E. gale blowing in Iceland and on the American coast, and an equally heavy S.W. gale in about 30° W. There are reductions of three charts for the 5th, viz., at 8 a.m., 3 p.m., and 8 p.m. These show the north-easterly progress of the area of lowest pressure.

On the charts of the 6th and 7th the direction of the wind indicates that another area of low pressure was advancing from the south-westward, which showed itself to the south-eastward of Newfoundland on the 8th. On this last chart three areas of low pressure are shown, the last just appearing on the south-western corner of the chart; this the extracts prove to have been very severe, and to have advanced to the north-eastward. It again was followed by another before our extracts end.

We have said a few words to illustrate the idea, that the point of lowest pressure and complete eddy may be formed just where the counter currents of air are in close contact, and that its apparent motion may be caused by the

closing in on each other of these currents of air, by which means the eddy is being constantly being re-formed at the new point of contact. The chart of 8 a.m., February 5th, is supposed to illustrate this idea.

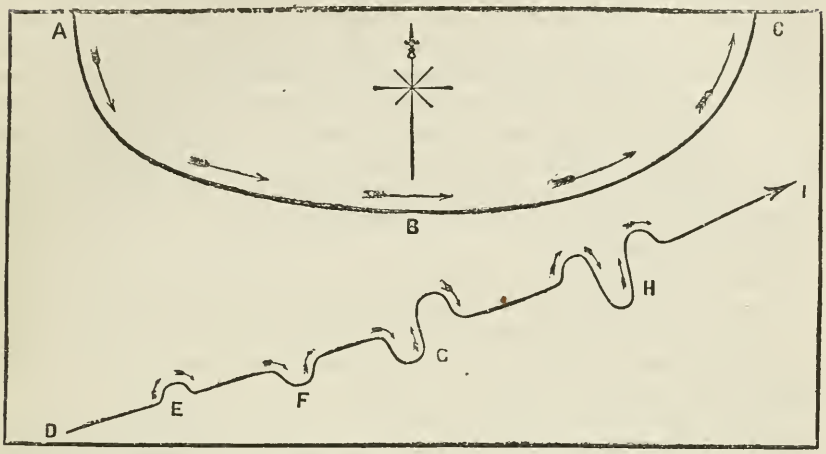
If we consult Buchan's isobars of mean pressure for these months, we find that they trend to the north-eastward from the Coast of America to England, and that the prevailing wind follows them, drawing rather towards the area of lowest pressure in the neighbourhood of Iceland. Hence, it seems fair to suppose that the tracks of these occasional eddies may be influenced by the main stream of air which seems to be flowing to the north-eastward round and into the area of lowest pressure, just as an eddy in a river is carried along by the main stream.

The data we have been dealing with proves that the points of *lowest* pressure in these areas of low pressure do not generally cross the British Islands; for instance, at 8 p.m., February 5th, the barometer was down to 27·38 in about 51° N. and 25° W., and at 8 a.m. of the 6th it was 28·22 in about 55° N. and 18° W., with a hurricane blowing from S.S.W. This direction of the wind indicates that there was a lower pressure to the westward, hence we may conclude that the area of *lowest* pressure took a very northerly course. Still, its influence was felt at all the self-registering observatories, taking Valencia first, and passing on to Aberdeen.

In the general remarks following the extracts for February 5th, we have pointed out how the gale which Valencia experienced later in the day is pictured on our 8 a.m. chart. The reader will do well to study the remarks published in the Quarterly Weather Report for February 4th to the 7th, as well as its Plate VIII. There it is shown on page 10 how at 8 a.m. of the 5th, "neither the daily chart nor the barograms showed any very serious sign of disturbance." On page 11 there is the following remark: "The facts appear to show that the gale which ensued on our coast was to the full as much to be attributed to the advance of the high pressure westward from Russia, as to that of the low pressure eastward from the Atlantic." The isobars on our charts for the 6th, 7th, and 8th, seem to prove the force of this remark.

Whatever may be the cause of these areas of lowest pressure, the five diagrams which follow the charts, as well as a large number of others received from the commanders of steamers to and from America, who are observing for this office, show that very many of them are experienced in the Atlantic, and the difference between the barometer curves of outward and homeward bound steamers, as well as the extracts from logs, show that they are travelling to the north-eastward. We have, then, two important facts: viz., 1st, by consulting Buchan's isobars, we find that during the winter months the normal state of pressure is high over the land on each side, and low over the sea in the central part of the Atlantic, also that the pressure gets lower as you go North from the Azores. Let the line A B C be supposed to represent a section of the normal state of pressure across the Atlantic, with a lower pressure to the North than to the South of it, then the arrows may be supposed to represent the normal direction of the wind.

Normal state of atmospheric pressure and wind between England and America in winter.



Undulations of barometric pressure moving 30 to 40 miles an hour to the north-eastward, with their accompanying winds.

2ndly. Besides this normal state, we have, as it were, the crests and hollows of waves of pressure moving to the north-eastward. These (the diagrams show) sometimes follow each other very closely, and may be represented by the the line D I. Keeping Buys Ballot's law (p. 184) in mind, let us suppose that a *ridge* of high pressure (E) be experienced travelling to the north-eastward, we know that it would be accompanied by corresponding winds, viz., northerly followed by southerly.

If merely a *depression* (F), then southerly winds would precede northerly.

If a *ridge and depression* (G), then northerly, southerly and northerly, would be the order of the winds.

If a *ridge and depression be followed by another ridge* (H), then northerly and southerly changes would be twice experienced.

Now it is hardly possible to look at the diagrams which accompany this paper without perceiving that they give sections of disturbances which could be explained by some one of the above cases. We may also suppose that after they have passed over a ship, the winds will be inclined to take up the normal direction as shown on the line A B C.

If the reader can suppose such changes of pressure as are represented by the line D I to be travelling to the north-eastward over a sea which has its normal pressure represented by the line A B C, he will get the idea we wish to convey.

In the course of this paper it has been frequently remarked that with a *steamer bound to the eastward*, the barometer was falling with a northerly and rising with a southerly wind. Now it is quite clear that this would *always* be the case with a steamer steering to the eastward, if the atmospheric pressure over the Atlantic were always in the normal state represented by the line A B C, and this order of rise and fall would be reversed with a steamer bound to the westward.

Again, suppose it were possible that a steamer could go to the north-eastward faster than an atmospheric disturbance represented by the depression F, and so cut through it, then it is clear that she would have a falling barometer with a northerly, and a rising barometer with a southerly wind, but if these disturbances move at a speed of 30 miles an hour, it is clear that a steamer could not outstrip them, but only keep longer under their influence when steaming fast to the north-eastward, than when standing still or going to the westward. Hence we may conclude that when the barometer falls with a northerly and rises with a southerly wind, as a ship steams to the eastward, she is experiencing, either the normal state of pressure, or a slowly moving disturbance.

We give only two instances of the barometer falling in a northerly wind, with a ship steaming to the westward, and they were both in the great gale of February 5th. They seem to indicate that the depression was increasing in intensity faster than the ships could move away from it. Such cases should be considered as important warnings.

The various extracts which follow the 8th of February, when an easterly wind set in on the north-eastern part of the chart, and worked its way to the south-westward, seem to show that such a state of things does not check the formation of cyclonic gales off the Coast of America, for they were still experienced, and judging from the Bermuda data the north-westerly winds were stronger. The routes which the gales took seemed, however, to be more northerly, as if the easterly wind interfered with their usual progress to the north eastward.

Considering the normal state of the wind, it seems clear that *in so far as the direction of the wind* is concerned, a sailing ship, bound from England to America at this season of the year (February), should keep her yards well in, and gain good way, even though she may get driven to the northward by the south-westerly winds which prevail on the eastern side of the Atlantic, for there is good reason to expect that the wind will draw to the northward of West as she gets over to the westward. The chances of meeting with ice, and other risks, would of course need careful consideration.

The very little progress (360 miles in a direct line N. ½ E. from lat. 31° 30′ N., long. 72° 30′ W., to lat. 38° N., long. 71° 15′ W.), made during the 11 days by No. 38 (the sailing ship *Nicoline*), bound from Santos to New York, makes it probable that she would have gained by making her northing several degrees further to the eastward, where the charts show that a southerly wind prevailed; instead of closing with the land, where there was an almost constant fresh northerly wind.

This paper gives sufficient evidence of the caution needed when a S.E. wind sets in with a falling barometer. Captains used to the trade know these gales well.

It is not necessary to repeat here what has already been said in the Barometer Manual, published by this office, on the use of the barometer to seamen, and its various action depending on a ship's course and speed.

Mr. Meldrum, the meteorologist of the Mauritius, is pursuing a similar enquiry with regard to the weather in the Southern Indian Ocean. There he finds that waves of high and low pressure follow each other on an easterly course at an average speed of about 20 miles per hour.

It will be remembered that we find these waves to travel at the rate of 30 or 40 miles per hour. When we consider how the northern part of the North Atlantic is much more surrounded by land than the southern part of the Indian Ocean, causing more sudden differences of temperature, we may well suppose that the differences of pressure will be greater in the North Atlantic, giving more activity to the changes of weather.

Mr. Meldrum also finds that the hurricanes of the Southern Indian Ocean take their origin in the district lying between the N.W. monsoon and S.E. trade, where the barometer is generally lower than to the northward and southward, just as we have already stated that the winter gales off the coast of North America take their origin over a lower pressure between two areas of higher pressure.

(92.) **British Isles.**—"Weather Charts and Storm Warnings" is the title of a little book published in 1876, and written by Mr. Robert H. Scott, M.A., F.R.S., the well-known Director of the Meteorological Office in London, as a help and guide to the sailor in using the drum and cone signals, and also to those studying the weather charts now so generally inserted in the daily papers. In this book will be found all the latest knowledge which has been gained relating to the winds. We give below a short summary of the most interesting facts.

It has been found that nearly all our storms are of a rotatory nature, and travel from S.W. to N.E., or from the westward towards the eastward, as is evidenced by the fact that out of twenty-three storms felt in Hamburg in the year 1869, twenty-two had previously passed over some portion of the British Isles.

These storms are divided into two classes—Cyclonic, in which the wind revolves *against watch-hands* around a centre of *low* barometric pressure, and Anti-cyclonic, in which case the wind revolves *with watch-hands*, or in the same direction as the hands of a watch, around a central area of *high* barometric pressure. Of these, the latter class are of rare occurrence; and whereas the cyclonic storms travel with some rapidity, the anti-cyclonic travel much more slowly. It is a remarkable fact worth mentioning, that in some places these storms are noticed to remain as it were stationary; this is frequently the case at the entrance of the English Channel, especially in early autumn, when the storms have been known to remain for days together in the locality. The centres of the storms generally pass on the northern side of the British Isles, hence we get more of the S.W., West, and N.W. winds than of those easterly winds which would be found on the northern side of the central area of lowest pressure. To this fact we may attribute the prevalence of westerly winds, shown in the table, drawn up from observations made at Liverpool. Owing to the smallness of the area covered by the British Isles, it is seldom that a perfect rotatory gale can be traced in its passage, but inferences are drawn from the observations made on small portions of such storms.

The best idea which we can gain, for practical purposes, of the winds which affect us in these islands, is that the air over the Atlantic ocean, North of latitude 40° N., is constantly flowing from West to East, like a

gigantic river. If such a river be flowing rapidly, we often see on its surface small waves, each with its own eddies and circulations, which are carried on with the stream. If we could look at the upper surface of the atmosphere, we should see much the same sort of conditions, except that what corresponds to the hollow of the wave would be a patch of defective pressure, while that which corresponds to the crest of the wave would be an area of excessive pressure.

(93) Liverpool.—At the former Liverpool Observatory, on the line of the Docks, an anemometer, the invention of Mr. A. Follett Osler, F.R.S., registered the force, or rather the motion and direction of the air, for the years 1852—1855; and the lines thus drawn by the machine itself are reduced on the diagram shown. The lines represent the actual direction and distance, according to scale, travelled by the wind over the instrument. Upon looking at these lines, except the general tendency to the eastward, there is no similarity between the years; yet, by taking the absolute motion throughout the year of the wind from any quarter, and forming a single diagram, there is seen to be a remarable identity in them all.

Thus, the main direction of the wind in 1854 was rather to the southward of *West;* in 1852, it was to N.W.; and in the other two years, although to the West, yet the wind was very devious.

Notwithstanding the wide difference in the line formed in these different years, yet if the whole amount of wind in each year is arranged graphically for each point of the compass, they are very similar to each other, showing that a fixed law prevails; which is still more evident if the duration of their prevalence were taken instead of their quantity or velocity. This is shown on the wind stars on the diagram.

(94.) The total amount of the *horizontal motion* of the air at the town of Liverpool, as registered by the anemometer, is also exceedingly alike in different years, as is shown by these figures:—

	Wind in Miles.	Calms.	Rain.	
			Quantity.	Duration.
1852	114,276	19 hours.	31.59 inches.	683 hours.
1853	105,989	27 „	22.47 „	625 „
1854	128,283	4 „	22.11 „	537 „
1855	103,405	12 „	22.57 „	510 „
Mean	112,989	15.5 hours.	24.69 inches.	597 hours or 24 days 21 hours.

The *seasons* have an influence on the velocity of the wind; thus these observations show that in *Winter* (December to February), the mean rate is 15.6 miles per hour; *Spring* (March to May), 12.1 miles per hour; *Summer*

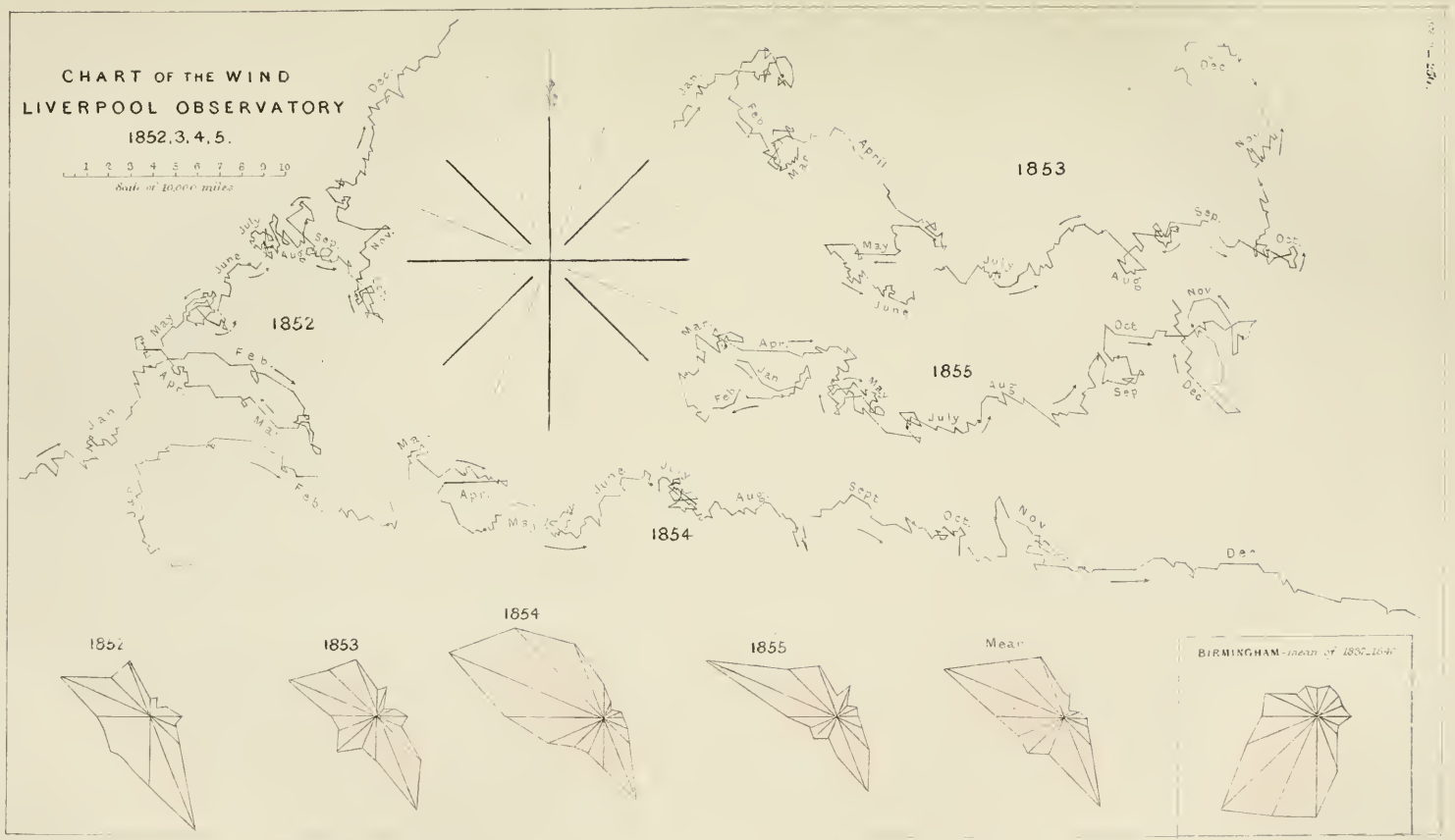


CHART OF THE WIND
LIVERPOOL OBSERVATORY
1852, 3, 4, 5.
1 2 3 4 5 6 7 8 9 10
Scale of 10,000 miles
1852
1853
1854
1855
Jan
Feb
Mar
April
May
June
July
Aug
Sept
Oct
Nov
Dec
1852
1853
1854
1855
Mean
BIRMINGHAM - Mean of 1852-1855

(June to August), 11.8 miles per hour; and *Autumn* (September to November), 11.5 miles per hour. In the day, winds are stronger than at night; thus, at midnight, it travels 11.2 miles per hour; 6 a.m., 11.8 miles per hour; 9 a.m., 12.9 miles per hour; noon, 13.2 miles per hour; 3 p.m., 14.6 miles per hour; 6 p.m., 12.7 miles per hour; and 9 p.m, 11.6 miles per hour.

Direction.	Miles per hour.
N.N.E.	5.2
N.E.	6.6
E.N.E.	7.8
E.	11.0
E.S.E.	9.6
S.E.	11.6
S.S.E.	11.4
S.	10.3
S.S.W.	11.8
S.W.	16.7
W.S.W.	15.5
W.	18.9
W.N.W.	19.0
N.W.	17.4
N.N.W.	12.7
N.	7.8

But the more important general deduction to be derived from these observations is the fact, as before alluded to (93), that all winds having a *westerly* bearing travel very much the fastest; those from South to East proceed at a much slower rate; while such as come from the North and East average but little more than a third of the rate of the westerly winds. All this is made clear by a glance at the column of figures in the preceding table, which gives the mean rate in miles per hour of the winds from the various directions; and will show further that the wind-roses and figures of Maury's and other charts do not give an accurate knowledge of this zone of winds, as the westerly winds, though by them made greatly to predominate, do not show the *actual amount* of those winds by, perhaps, one-half or two-thirds of their real quantity. All the strongest gales recorded in those years come from western quarters.

(95.) Notwithstanding that the results shown by the Liverpool anemometer are of the utmost value, and great labour and skill have been exercised in reducing them to a comprehensive form by Mr. Hartnup, the able superintendent, yet they contain evidence of the interference of land influences, as alluded to in (93), page 250. By his last dissertations,* as here shown, the winds from N.N.W. and S.S.E. were most prevalent, whereas the prevalent direction in England is from the West, with the polar current from the N.E.; showing that the form of the valley of the Mersey has much to do with diverting the normal direction of the wind. Still the observations, as before stated, are most instructive and important.

(96.) There is one remark respecting *land* observations, which is important:—"All the synoptic charts hitherto advanced at the Board of Trade exhibit a marked *diminution of force* on land compared with that on the sea coast. Indeed, the coast itself offers similar evidence in its stunted, sloping trees and comparative barrenness."† The trees in many localities form excellent wind-vanes, as, by their growth, they show exactly the direction from whence the most powerful and persistent winds come.

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* Report of the British Association, 1856," page 137, &c.; and also "Report of the Direction and Strength of the Wind at the Liverpool Observatory, 1852—1857." It is from these sources that the above facts and figures are derived.

† Third Number, Meteorological Papers, by Admiral FitzRoy, 1858, page 99

It would seem, also, that the land has a tendency to draw the wind towards it, so as in some measure to make it appear that the prevalent direction is more across the line of direction of that coast than is really the case. Looking at the simultaneous observations now daily collected and published for a great extent of coast, this is very apparent. All these arguments tend to lessen the value, in some degree, of those extended and accurate records of the wind on land. The mean direction of the wind, derived from land observations, however, as given by Kämtz and Dové, is as follows:—

England	S. 65° W.	Denmark	S. 62° W.
France and Holland. .	S. 88° W.	Sweden	S. 77° W.
Germany	S. 76° W.	N. part of United States	S. 86° W.

(97.) **English Channel.**—The following are the results of fifteen consecutive year's observations upon the wind, taken by M. Nell de Bréauté, at the Chapelle, near Dieppe, at an elevation of 410 feet above the sea:—

Direction of the Wind.	Mean Number of Days.	Maximum.	Minimum.
South.	37	In 1828— 54 days.	1820 and 1825—28 days.
S.W.	93	1823—121 „	1831—67 „
West.	48	1830— 72 „	1829—31 „
N.W.	52	1825— 72 „	1832—38 „
North.	36	1819— 56 „	1821—21 „
N.E.	41	1826— 54 „	1828—22 „
East.	23	1820— 41 „	1821—12 „
S.E.	31	1818— 46 „	1827—19 „
	Total, 361 days.		

From this table the following conclusions may be drawn:—
In the 365 days of the year there are about 361 of wind, and 4 or 5 of dead calm.
If the horizon is divided into four equal parts, there will be—

135 days with the wind between South and West,*
94 „ „ between West and North,
71 „ „ between North and East,
61 „ „ between East and South.

The maximum of winds between S. and W. takes place in November and Dec.
The minimum „ „ May and June.
The maximum of winds between W. and N. takes place in July and August.
The minimum „ „ October and December
The maximum of winds between N. and E. takes place in May and June.
The minimum „ „ October and November.
The maximum of winds between E. and S. takes place in December and June.
The minimum „ „ June and January.

* Upon comparing this direction of West to South with the Liverpool observations, as given in the diagrams, &c., on page 230, the disturbing action of the land will be evident.

Moderate winds from North and N.E. are those which bring fine weather. In summer the N.E. wind blows more particularly in the afternoon; in the morning the wind is S.E., a slight breeze, and towards noon it changes quickly to N.E.; then it freshens, and towards the evening it sinks; at night it is calm, and the coolness condenses the vapours. When this condensation does not take place, it is a sign of a change of wind.

Dead calms are of rare occurrence, and do not last long, except during summer. When they occur in winter, it is regarded as a precursor of bad weather. It is always, in reality, an indication of a change in the direction of the wind.

(98.) The foregoing remarks will be ample for the purpose of giving the sailor an idea of the relative duration, force, and direction of the wind in that part of the Atlantic. Reverting to the observation made on page 250, it may be re-stated,, that from the variable nature of its changes, and the great difference that is found to occur between one period and another, yet when these are combined in a long series of observations there is great similarity; and this will be accounted for in a measure by the researches of our own and the U. S. Meteorological Offices, which have shown that there is a systematic progress of air from the westward to the eastward in our latitudes, see pp. 243—249 and pp. 249—250. For the service of the mariner, in foretelling what weather is approaching, he is referred to Admiral FitzRoy's "Barometer Manual," or its modern representative, "Instructions in the use of Meteorological Instruments," issued by the Meteorological Office in 1875, and to "Weather Charts and Storm Warnings," a little work published in 1876, and edited by Robert H. Scott, M.A., F.R.S., &c., the present Director of the Meteorological Office.

The diagrams adjoining have been drawn up from the Pilot Charts in the same manner as those given on p. 201, to illustrate the trade winds. They are selected from those parts of the ocean most generally traversed by ships crossing it in the strength of these westerly winds. Their localities are shown by the latitude and longitude assigned to such diagram, which thus represents the wind in the region for 150 miles around that position. But, as will be seen at a glance, there is a great similarity in the general features of them all.

The principal upon which these wind-roses are constructed is explained on page 200 (43); and the six examples there given are analyzed in that page. The remark in the note (*) should be particularly attended to in connection with the observations in these anti-trade winds, as it is clearly futile to endeavour to lay down any *refined* rule for their practical application. As there certainly is a doubt as to the accuracy of the recorded direction of the wind to the extent of two points—to lay down rules for sailing over any area with a course limited to a few degrees, certainly appears to be a needless refinement with the present data to argue upon, but in future years extended knowledge may make it possible to lay down such rules.

(99.) In comparing these observations, recorded by Mr. Osler's self-registering wind-guage at Liverpool, as shown in page 251, with the second diagram adjoining,—that for lat. 52° N., and long 15° W., or off the West

coast of Ireland, where we might expect to find some degree of similarity, there appears to be scarcely any accordance at first sight. But upon referring to the evidence of the greater force of the *westerly* winds over the easterly, as shown by the figures (94), page 251, we arrive at a reason why this apparent discrepancy exists. If the arrows on the West (or windward) side of these diagrams were enlarged in proportion to the relative force, and the easterly arrows diminished in like manner, there would be a much nearer approximation. This comparison will demonstrate how the direction of the valley of the Mersey, and the line of docks and walls at Liverpool around the observatory, have diverted the true direction of the winds. For the purpose of still further exemplifying this, the mean of the observations recorded at Birmingham for four years, by another anemometer of Mr. Osler's, is given. Although this is inland, and necessarily subject to land influences, the westerly preponderance is clearly marked, and serves to bear out the modern discovery of the progress of cyclonic disturbances across the British Isles from West to East, their centres generally passing North of our island.

The diagrams, as we give them, or the figures in Maury's chart, must be studied, should any greater exactness in the relative duration of any wind be required than can be acquired at a cursory glance; and in the former case, as was before explained, the length of the award applied to the scale at the bottom of the plate will give the exact ratio *per cent.* of the wind represented by that arrow.

One general remark only need be given; it is, that about the Azores the greatest irregularity in the direction of the wind appears to occur in these latitudes; during the summer months the wind is frequently from northern quarters, driving before it the colder water from the polar regions, and thus abnormally reducing the temperature. Besides this, there appears to be a conflict between this southern and western tendency, and the Trade which is established to the West of them.

(100.) Bay of Biscay.—The winds in the northern part of the Bay of Biscay do not differ greatly from those experienced in the entrance of the English Channel, and therefore the same remarks are applicable to each. As we approach the head of the bight, however, it is necessary to use great caution, and observe all indications of the change of the wind.

In summer, the reigning winds on the coast at the head or S.E. angle of the bay, are those from N.E. and East, which become North and N.N.W. in the Gulf of Bilbao. These alternate with N.W. and West winds, which generally drop at night, during which they are replaced by the land breeze. In autumn southerly winds prevail, and are usually very violent. They last for two or three days, and sometimes for eight or nine, the weather being clear; but as soon as they shift to S.S.W., the sky becomes covered with heavy clouds, and almost immediately the "vendavale" or dirty weather from S.W. and West comes on. These, after some days' duration, pass N.W., with heavy rains and a stronger sea. This wind, much dreaded by seamen, from the heavy surf which it sends in, and because it debars entrance to the few harbours on the Biscayan coast, is very lasting. It is not uncommon to find it continue for fifteen days consecutively, with only two or

three days of even moderate weather. But with this N.W. wind there is no fear of being drifted on to the coast, as it is never entirely hidden, and there are sufficiently clear intervals to allow you to make out the land.

It is not so with North and N.N.E. winds; they blow perpendicularly to the coast, and will not allow ships embayed to clear off shore. They completely hide the land, and are accompanied by much rain and hail, which follow each other almost without interruption. They generally last but a short time, and occur between the middle of December and the end of February, or the beginning of March.

The N.E. wind is not frequent in summer, but it is accompanied by thick fogs, in which case it blows heavily for two or three days, and is then called *nord-este pardo* (the dirty north-easter). When it shifts to the S.E. by the East, you should as far as possible keep in with the coast, because the wind will shortly come from South. When the South wind, after lasting two or three days, drifts to S.W., either get off the land or else enter some harbour, because the N.W. wind will soon come on.

In the spring the winds are generally very light, and nearly always from N.W. or S.W., accompanied by rain. In some years these winds last until July.

The ocean-swell from the N.W., coming from the open Atlantic, is the heaviest and most dangerous on this coast; it penetrates every harbour and creek, and there is no shelter from the waves in any of them until the bars at the entrances become uncovered by the ebb tide. This dangerous state of the sea commences in the middle of September or beginning of October, and, with slight interruption, it continues through two-thirds of the year. This swell is almost always a precursor of the wind from that direction, and sometimes precedes it by twenty-four hours. Sometimes in the summer season enormous waves are seen to set in during perfectly calm and serene weather. They close every harbour, and dash on the coast like enormous mountains of water, and break on the outlying banks with 20 to 40 fathoms water over them. It is needless to state that these are most dangerous to a ship close in with the shore. Captain FitzRoy states that they overtopped the mainyard of the *Thetis*, 56 ft. above the water-line.

In August there is a danger of encountering a peculiar squall or tornado, called on the Biscayan coast *galerna*. It is formed on the land by the sun's heat, and shifts by the S.W.; the horizon becomes obscured, and it quickly increases in strength as it passes to N.W. Every precaution should be taken against them; they are excessively violent, and last three or four hours. They bring rain, and sink at night in the N.W. Sometimes, especially in summer, the *galerna* is a sudden shift from South to N.W. without any notice, and in this case is very dangerous. It is also common to see winds blowing at the same time from South and N.W., only separated by a narrow belt of calm between the heavy waves they send up.

The South wind is foretold by the atmosphere being so clear that the distant lands and inland peaks become very distinct, and apparently close-to. If the high lands are very clear and distinct, with the wind from East, and a line of ashy-coloured clouds should be seen on the peaks, the South wind is coming on. The local sailors also can foretell the approach by the clouds

of dust raised inland, or by the direction of the smoke from the dwellings on shore.

(101.) North Coast of Spain.—About Santande the prevalent winds in winter are between South and N.W. by the West. With southerly winds the atmosphere remains clear for a few days, but they are then considered to be the precursors of N.W. winds. They commence in October and cease in February. When South winds bring clouds and rain they shift soon to S.W., and then rapidly to West, always accompanied by fogs, and terminate at N.W., blowing violently, and raising a heavy sea with strong gusts. When they are at N.W. there are clear intervals which allow the sailor to make out his position on the coast.

The heaviest gales generally commence at South very violent, and they are the more strong according as the sky is clearest. When it is overcast you may look for it from N.W. with squalls.

If the N.W. wind should shift suddenly to North and N.N.E. it becomes very dangerous, because it will not allow vessels to find shelter, on account of the rapidity with which it closes all the harbours.

If after two or three days of northerly wind it returns to W. by the N.W., it will increase in that direction; but if it shifts to the N.E. the weather will be more quiet, and there may be some days of fine weather. When, after a continuation of N.E. winds, it should shift to S.E. by the East, you may expect southerly winds soon, and with them bad weather again. In autumn there is a continuation of fine weather, especially after the bad weather which usually accompanies the equinoxes.

The spring is almost always a continuation of the winter, during which the winds from down the coast prevail; they are not so strong, but the accompanying rains are more abundant.

In summer, which generally begins in July, the prevalent wind is from N.E. Close in with the land they haul to seaward, while the sun is up, on the horizon, and to the land during the night.

The barometer rises with winds from W. to N.E. by the North, and falls with all other winds.

We have no trustworthy observations on the prevailing winds on the coast of Portugal, as affected by local circumstances.

(102.) America.—Gulf and River of St. Lawrence.—Rear-Admiral Bayfield states that, during the navigable season, the prevailing winds are either directly up or directly down the estuary of the St. Lawrence, following the course of the chains of high lands on either side of the great valley of the river. Thus, a S.E. wind in the gulf becomes E.S.E. between Anticosti and the South coast, E.N.E. above Point de Monts, and N.E. above Green Island. The westerly winds do not appear to be so much guided in direction by the high lands, excepting along the South coast, where a W.S.W. wind at the Isle Bic has been seen to become West, W.N.W., and N.W., on running down along the high and curved South coast, until it became a N.N.W. wind at Cape Gaspé. These winds frequently blow strong for three or four days in succession; the westerly winds being almost always accompanied with fine, dry, clear, and sunny weather; the easterly winds as frequently with the contrary, cold, wet, and foggy. In the spring the

easterly winds prevail most, frequently blowing for several weeks in succession. As the summer advances, the westerly winds become more frequent, and the S.W. wind may be said to be the prevailing wind in summer, in all parts of the river and gulf. Light South winds take place occasionally; but North winds are not common in summer, although they sometimes occur. Steady North winds do not blow frequently before September, excepting for a few hours at a time, when they generally succeed easterly winds which have died away to a calm, forming the commencement of strong winds, and usually veering to the S.W. The N.W. wind is dry, with bright clear sky, flying clouds, and showers. After the autumnal equinox, winds to the northward of West become more common, and are then often strong steady winds of considerable duration. In the months of October and November, the N.W. wind frequently blows with great violence, in heavy squalls, with passing showers of hail and snow, and attended with sharp frost.

Thunder storms are not uncommon in July and August; they seldom last above an hour or two, but the wind proceeding from them is, in general, violent and sudden, particularly when near the mountainous part of the coast; sail should, therefore, be fully and quickly reduced on their approach.

Strong winds seldom veer from one quarter of the compass to another directly or nearly contrary; in general they die away by degrees to a calm, and are succeeded by a wind in the opposite direction. It is not here meant that they may not veer to the amount of several points. N.W. winds seldom veer round by North and N.E. to East and S.E.; but they do frequently, by degrees, to the S.W., after becoming moderate. S.W. winds seldom veer by the N.W. and North to the eastward, but sometimes by the South to S.E. and East. Easterly winds generally decrease to a calm, succeeded by a wind from the opposite direction.

In the fine weather, westerly winds of summer, a fresh top-gallant breeze will often decrease to a light breeze or calm at night, and spring up again from the same quarter on the following morning; under these circumstances only, may a land-breeze off the North coast be called for. The same has been observed of the South coast also, but not so decidedly, nor extending so far off shore. Admiral Bayfield adds, "I have occasionally carried the North land-wind nearly over to the South coast just before daylight; but have never observed the South land-wind extend more than 5 or 6 miles off, and that very rarely. Under the same circumstances, that is, with a fine weather westerly wind going down with the sun, a S.W. land-breeze will frequently be found blowing off the North coast of Anticosti at night and during the early part of the morning. If, however, the weather be not settled fair, and the wind does not fall with the sun, it will usually prove worse than useless to run a vessel close in-shore at night in the hope of a breeze off the land. Such is the usual course of the winds in common seasons, in which a very heavy gale of wind will probably not be experienced from May to October, although close-reefed topsail breezes are usually common enough. Occasionally, however, there are years, the character of which is decidedly stormy. Gales of wind, of considerable strength, then follow each other in quick succession, and from opposite quarters.

Nova Scotia.—The prevailing winds on all the coast are from W.S.W. to S.W., nearly as steady as *trade winds*, excepting that during the summer months they are rather more southerly, accompanied with but little intermission by fog, which requires a north-westerly wind to disperse it. It is, therefore, recommended not to leave an anchorage without making arrangements for reaching another before dark; or with appearances of a fog coming on, which, with a S.W. wind, is so sudden, that you are unawares enveloped in it; nor to keep at sea during the night, if it can be avoided. Whenever the wind blows directly off the land the fog is soon dispersed.

Sable Island.—In the spring and summer months dense fogs or rain almost always accompany all winds from the sea, from E.N.E., round South, to W.S.W. In winter, the rain is frequently replaced by snow. During the autumnal and winter months, winds from between North and West become more frequent, and, being off the land, are always accompanied with clear weather.

Strong gales of wind do not often occur in May, June, or July; but after the middle of August they are often of great strength, and it becomes the more necessary to attend carefully to the indications of the barometer. Strong winds from East, round South, to W.S.W., are always accompanied by a falling barometer. When, therefore, these winds begin to abate, and the barometer at the same time ceases to fall, a change of wind, more or less sudden, to the opposite direction may be expected, with a rising barometer and fine weather; and if it be winter, with intense frost, coating the vessel, her sails, and rigging, with ice.

Again, a high barometer, stationary or beginning to fall, indicates that a S.E. or S.W. wind, with accompanying rain and fog, is not far distant; and if, at the same time, there be a bank of clouds rising above the north-western horizon, the indication is certain.

South Carolina, &c.—About this coast, if the wind blows hard from the N.E. quarter, without rain, it commonly continues so for some time, perhaps three or four days; but, if such winds are attended with rain, they generally shift to the East, E.S.E., and S.E. S.E. winds blow right in on the coast; but they seldom blow dry, or continue long. In six, eight, or ten hours after their commencement, the sky begins to look dirty, which soon produces rain. When it comes to blow and rain very hard, you may be sure the wind will fly round to the N.W. quarter, and blow hard for twenty or thirty hours, with a clear sky.

North-west winds are always attended with clear weather; they sometimes blow very hard, but seldom for longer than thirty hours. The most lasting winds are those which blow from the S.S.W. and W.N.W., and from the North to the E.N.E. The weather is most settled when the wind is in any of these quarters.

In summer time thunder-gusts are very common on this coast; they always come from the N.W. quarter, and are sometimes so heavy that no canvas can withstand their fury; they come on so suddenly, that the greatest precaution is necessary to guard against the effects of their violence.

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8.—HURRICANES.

(103.) Among the most extraordinary phenomena of nature may be classed those tremendous meteors, the hurricanes and tornadoes of the tropical regions. Until within a recent period they were very imperfectly understood, and were only regarded as terrible convulsions of the aerial system, when all order seemed to be broken up. But these, like many other apparent anomalies in nature, have been found reducible to system; and their various seemingly capricious motions all subject to general rules, which, in this case, have been aptly denominated "*The Law of Storms.*"

The discussions on the *progressive* nature of hurricanes appear to have originated in a paper, entitled, "Remarks on the Prevailing Storms of the Atlantic Coast of the North American States, by William C. Redfield, of the City of New York," 1831, which has proved to be a very important and valuable addition to nautical literature. The subject, adopting the "Redfield Theory," has since been amplified and illustrated by the late Lieutenant-Colonel (afterwards Sir) William Reid, R.E. and C.B.,* Governor of the Bermudas and of Malta, in his beautiful volume, bearing for the title, "An Attempt to Develop the Law of Storms by means of Facts, arranged according to Place and Time, and hence to point out a Cause for the Variable Winds, with a view to practical use in Navigation," &c., 1838. As connected with this subject, the names of Redfield and Reid will be imperishable.†

We say that the discussion appears to have originated in the beforementioned works; but, without deciding on the claims of priority, it must be mentioned that, besides the names of Reid and Redfield, those of Mr. Piddington, at Calcutta; of Dr. Thom, and more recently Professor Meldrum, in the Indian Ocean; of Mr. Espy, in America; and of Professor Dové, at Berlin, must be enrolled with them, as the primary instigators of the enquiry into the origin and nature of storms. Mr. Piddington's "Hornbook" contains the most valuable information on this important topic.

There are various names applied to these storms; Cyclones, Revolving Storms, Hurricanes, Tornadoes (Spanish and expressive "turned"), Typhoons, &c.; but all are meant to describe the same thing.

In the foregoing remarks on the winds, on pages 174, 175, the general

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* The origin of the relvolving theory has been attributed to others earlier in the field than Redfield and Reid. Among others, to Colonel Capper, who published his well known work on winds and monsoons, in 1801; to Romme, a French author, in 1806; and to several others. But these all fell short of establishing the law, inasmuch as they only noticed the shifting charater of the winds in one spot, and did not reach the conclusion that these shifts had an invariable character, and that the whole meteor was progressive.

† "My attention was first directed to the subject from my having been employed at Barbadoes in re-establishing the Government buildings blown down in the hurricane of 1831; when, from the violence of the wind, 1,477 persons lost their lives in the short space of seven hours. I was induced to search everywhere for accounts of previous storms, in the hope of learning something of their causes and mode of action."—*Reid, "Law of Storms."*

theory of atmospheric circulation is described; and in (19 and (20), p. 184, is a *resumé* of the whole, which will show the localities in which these phenomena occur. The subject is also illustrated by the plates in this volume.

(104.) Although the "Law of Storms" is now fully recognized, yet opinion is still divided as to the real character and condition of these remarkable meteors. Reid, Redfield, and others, contend that they are real vortices—currents of air *revolving* round a progressive centre; others, as Thom, and Meldrum, contend that the wind blows in *spirals* around this centre; Epsy, that the wind blows *toward* the centre; others, again, consider that the *vertical* motion of the air will explain many of the phenomena. It is also argued that, instead of a circle, the form of the storm is elongated, ellipsoidal, or even straight, moving broadside onwards. Jinman considers that, as the air is blowing away from one area, another current necessarily blows towards and into that area, causing the peculiar features of these hurricanes. It would be out of place, and far too discursive for this work, to discuss these various propositions. They many readily be found in the numerous works extant.

(105.) Capt. George Jinman thus expounds his views:—Every hurricane or gale has two distinct sides, formed by two currents of air flowing in opposite directions, and crossing each other at two points. The two sides are not always equally developed at the earth's surface—that is, the one often blows harder than the other; it is but seldom, in fact, that the winds in the two sides are equal in force. The greatest force will be found at either *confluence*, but rarely of equal force at both. It may blow with hurricane violence at *both confluences*, and only a moderate gale at the sides.*

The centre of a storm is not the most dangerous part. There are times in which it would be possible for a steam-ship to pass from one side of the gale to another, across the centre, and yet not experience more than a moderate gale, whilst vessels on either side of her, under the confluences, may be exposed to violent hurricanes. A vessel may become embayed, as it were, in a storm, in such a position that it may be almost impossible for her to escape altogether uninjured. There are many positions, indeed, in which a ship, especially a dull sailing one, may be overtaken, and be unable to escape. One confluence is generally more distinctly marked than the other, especially in extra-tropical latitudes; so much so, indeed, that, for a long time I imagined that there was but *one;* which at that time I named the *centre-line*, or *core* of the gale. The one on the West side of the centre, in either hemisphere, is always more marked than the one on the East side. When I say *more marked*, I mean that the *meeting* of the two winds may be seen more distinctly; as, for instance, in the North Atlantic, when the wind *flies* from S.W. to N.W. This takes place at the confluence on the West side of the centre. On the East side, where the winds forming a confluence are from the S.E. and S.W., their meeting is not so distinctly marked. The wind seldom *flies* from S.E. to S.W.; it more usually *veers*, but rather more quickly than at any other part of the storm. The reason is simply this:

* I am satisfied that many of those which have been described by some writers as double hurricanes or cyclones, were nothing more than the two confluences of the same storm.

the S.E. and S.W. winds, flowing out from the equator, are more highly charged with vapour, and are warmer than a westerly or northerly wind, and consequently have a greater tendency to ascend and to mix with each other. A N.W. wind, on the contrary, is a dense, cold wind—a descending wind; and on coming in contact with a S.W. wind it condenses the vapour which the latter has taken up, thus producing torrents of rain at their junction. Here we have one material proof that the winds do not blow in circles; for, on passing from one wind into another, as from a S.W. into a N.W., a long bank of *nimbus* (rain-cloud) may often be seen stretching away from S.W. to N.E., or with the wind just left, and at right angles to the wind entered, before which it is being rapidly driven; showing distinctly that the two winds are in contact, and blowing at right angles to each other. This could not be the case if the wind blew in circles—if it was one continuous current of air blowing round a centre.

(106.) Dr. Milne Home, President of the Council of the Scottish Meteorological Society, remarks: *—With regard to this cyclone (August, 1870, *see* p. 283), there can be no doubt that the winds which formed it were rotating round a central area. It was, in fact, a gigantic whirlwind. The way in which the wind veered at all the places over which it passed, cannot be explained on any other supposition. The depression of the barometer within the area of the whirlwind, and the circumstance that the depression was greatest everywhere at or near the centre, also indicates another important feature, viz., that there was a diminished atmospheric pressure within the whole area of the cyclone, and most of all at the centre.

In a paper published in the Journal of the Scottish Meteorological Society for March, 1869, it was pointed out that the whirls which frequently occur in the atmosphere, known as water-spouts, whirlwinds, and dust storms, are formed by currents of air ascending from the earth's surface spirally and rotating at the same time. These ascending currents have been distinctly noticed by various articles (such as hay, straw, branches of trees, and in some cases animals) being seen to be carried up in the interior of the whirling cylinder. If it were possible to have an aneroid in the interior of it, a depression indicating diminished atmospheric pressure would most probably be observable. In that paper it was attempted to be shown that cyclones had many features in common with water-spouts, dust storms, and whirlwinds. It appears that this West India cyclone, in some of its features, strengthens the spiral theory advocated by Mr. Meldrum.

The diminished weight of the atmosphere at the places passed over by the cyclone may be accounted for by the suction which draws air towards it from all quarters and the effect of which is necessarily to produce revolving currents ascending spirally towards the place is the upper regions of the atmosphere where a vacuum or great rarefaction originated.

In the paper before referred to a description of a water-spout was given which was seen to extend upward to a height of 1,700 feet, and of several dust storms which were more than double that height. If there be a close analogy between cyclones and these smaller whirls, it may be inferred that the gigantic whirls composing the former are greatly higher, or perhaps several miles in height, and consequently the direction of the wind

experienced during a cyclone may not always agree with the direction of the progress of the scud above, which may be accounted for by the spiral column not rising perpendicularly in the air.

The most difficult part of the cyclone theory remains to be mentioned. What causes the *suction* to which the indraught of air may be attributed? What determines the course which all these West India cyclones take in their passage over the earth's surface? the last question is the less difficult of the two. If the cyclones are formed, as they appear to be, in the Atlantic Ocean, a little to the North of the equator, it is evident that they must move in the first instance to the westward, because the general atmospheric current is in that direction. When they reach the West India Islands they get into another current, which carries them first N.W., then North, and ultimately N.E.

But how is the whirling cylindrical column of a cyclone formed? There are several ways in which a whirl may be formed. (1.) If a tub is filled with water, and a small orifice is made in the bottom, the water in the tub as it runs out rotates. At first only the part over and near the orifice rotates, but ultimately the rotation extends to more distant parts. (2.) If a stream of water is made to flow through a body of water which is quiescent, whirls or eddies will be formed which consist of columns more or less vertical. They may be seen any day in rivers where the current passes a point of rock projecting into the stream, and when that current comes in contact with the body of the water sheltered by the rock. These eddies are still more common where two currents, running in different directions, touch one another; along the line which separates them whirls are formed, the rotation being in the direction of the stronger stream, and its progressive motion being also in the same direction. (3.) If a long glass cylinder is immersed a little way into a body of water, and the air is suddenly exhausted or rarefied by draining it out at the top of the cylinder, the water rises, and in rising rotates. This has been distinctly seen in the case of dust storms, water-spouts, and whirlwinds.

With regard to the cause of the air rising. There must e frequently, in the upper regions of the equatorial atmosphere, condensations of the warm vapours which are carried up from the surface of the ocean by the ascending aerial currents. These condensations will produce great rarefaction, and that rarefaction will draw towards it air from the lower regions of the atmosphere, and in drawing it will probably cause rotation *

(107.) One more remark may suffice. Is it not possible, nay, probable, that each of these theories may be correct as to individual cyclones, which may be (and are of such varied character as not to be reducible in all cases to a fixed rule? However, it is certain that in many examples the true revolving storm is the proper appellation, and the rules now applied will give the means of avoiding their fury.

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* To cause this rotation the ascending current would appear to require a limited space to pass through, and this hole, as it were, might be formed at a point of contact of an upper and under strata of three strata of air. That it is possible for patches of air of different consistences to exist side by side, has been proved by the recent fog-signal experiments carried on by the Trinity House.—Ed.

In our description of the winds, &c., pages 174—176, we gave the theory that has been universally received as the cause of the trade winds and their attendant phenomena in the general atmospheric currents.

(108.) From all the investigations on the subject, the following conclusions have been arrived at. The hurricane, or rotary storm, commences within the tropics, on either side of the equator; *that in North latitude, the motion of the revolving circle is from right to left, past the North, or against the sun*, i.e., in the opposite direction to the hands of a watch, and that the storm progresses to the W.N.W., N.W., North, forming a cycloidal curve in about 30° North lat., and runs off to the N.E.

South of the Equator, or in the southern hemisphere, *this rule is reversed, the storm revolving from left to right, or* with watch hands, and passing onwards in a S.W., and finally in a S.E. course.

The diameter of these circular vortices varies from 40 to 50, or even 1,000 miles, probably increasing in size in their onward progress. Their rate of travelling varies from 3 to 50 miles per hour.

There are numerous minor peculiarities connected with these cyclones, which will be gathered from the subsequent remarks. But the great point with the mariner is to avoid their fury; and, having ascertained their character and his relative position on the meteor, to make the best course for getting away from it. Sir William Reid's "Law" is simple, and will be best given in his own words.

(109.) *Sir W. Reid's Rule for laying Ships to in Hurricanes.*—That tack on which a ship should be laid to in a hurricane has hitherto been a problem to be solved, and is one which seamen have long considered important to have explained.

In these tempests, when a vessel is laying-to, and the wind veers by the ship's head, she is in danger of getting stern-way, even when no sail is set; for in a hurricane the wind's force upon the masts and yards alone will produce this effect should the wind veer ahead; and it is supposed that vessels have often foundered from this cause.

When the wind veers aft, as it is called, or by the stern, this danger is avoided, and a ship then comes up to the wind, instead of having to break off from it.

(110.) If great storms obey fixed laws, and the explanation of them in this work be the true one, then the rule for laying a ship-to follows like the corollary of a problem already solved. In order to define the two sides of a storm, that side will be called the right-hand semi-circle which is on the right of a storm's course, as we look in the direction in which it is moving, just as we speak of the right bank of a river.

The rule for laying a ship-to will be, *when in the right-hand semi-circle to heave-to on the starboard tack, and when in the left-hand semi-circle to heave-to on the port tack in both hemispheres.**

(111.) Mr. Redfield says:—"At stations within the tropics, the changes of wind, during the passage of the hurricane, are sometimes known to *exceed*

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* "An attempt to Develop the Law of Storms," 3rd edition, 1850, page 509; and "The Progress, &c., of the Law of Storms and of Variable Winds," 1849, page 25.

those which pertain to the passage of a regular circuit of wind; these changes sometimes running through the entire circuit of the compass, and even more. Again, they have been known to shift *backward and forward*, in alternate and fitful changes, when near the crisis of the storm. These phenomena, so far from disproving the rotative character of these gales, only prove something more, and afford, at least, probable evidence in support of one or both of the following positions:—1. That high land and other obstructions often produce sudden and fitful gusts and changes in these violent winds. 2. That, in accordance with our observations of minor vortices, the action of rotation is often impelled, excentrically, around a smaller circuit, in the interior of the advancing storm.

"In the northern inter-tropical latitudes the recession or departure of the south-eastern limb of the storm appears to be followed, not unfrequently, by strong squalls or gusts from the S.E., this being the true course of the general trade wind that determines the track of the storm. These gusts, or squalls, if mistaken for the regular action of the hurricane, may occasion erroneous deductions in regard to the course of the storm."

At stations apparently within the regular track of the storm, there will sometimes be an absence of violent wind; or the violence will pertain to only one of the phases, which the storm presents, in its regular course over such locality.

"Some storms are interrupted in their development by the near approach of another storm. Care must be taken, therefore, not to mistake the N.E. wind of a storm whose north-western limb is thus intercepted by a bordering storm, and which hence is sometimes followed by the natural current of air from the S.W. quarter, for the changes that pertain to the centre of the gale."

(112.) **The Season** which is most liable to these visitations is between July and October; they are comparatively rare during other months, though not entirely unknown. The following is a list of 113, arranged in the months they occurred in the West Indies, taken from Mr. Birt's Hand-Book:—

Jan.	Feb.	Mar	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Total.
0	1	2	0	0	4	15	36	25	27	1	2	113

(113.) **The Barometer** will be found an unerring indicator of the approach of these meteors, provided proper attention be paid to its monitions. As a general law, the following will be its usual vibrations:—Just previous to the commencement of the hurricane, the mercury will suddenly rise above its ordinary level;* soon after it will begin to fall, and the wind probably rises, showing that the storm has begun. The mercurial column then begins to descend, rapidly at first, and then more slowly, till the centre of the hurricane has passed over, when it begins gradually to rise, and the reverse of the commencement ensues; it attains a higher level, and then as suddenly falls to the mean height. This is supposing the whole of the meteor to pass

* "Reid," page 421.

over, and the centre to be crossed; the mercury showing the quantity of atmosphere above. Upon a little consideration, it will be evident that the form of the surface of the revolving storm, or the section of the vortex, is described by the variations, in the barometric column. It by no means follows that, practically, this will always be found: a ship may only skirt the exterior of the storm, and, consequently, the mercury will only rise, or oscillate, according to the relative position of the hurricane and the ship; but it may be taken as an indication, when the barometer begins slowly to rise, after being depressed, that the greatest danger has passed over, or that the ship is steering away from it. Therefore, should there be any sudden change in the barometer, either rising or falling, its indications should never be neglected, especially during the period, and in the regions, subject to these storms.* The barometer sometimes sinks *two inches* during the progress of a hurricane.

One great advantage in the Aneroid barometer is, that its variations occur simultaneously with their causes. In the mercurial barometer the friction of the mercury on the tube, and other reasons, concur to make the column rise or fall at some time after the change has occurred. It this the Aneroid barometer possesses great advantage, and it has another very great claim to notice—that it clearly shows very minute changes, which the oscillation or pumping motion of the mercury in very bad weather will not allow to be estimated.

(114.) The main object of the navigator, when assailed by a hurricane, should be to keep his vessel *clear of the centre of rotation*, as there the strength of the wind concentrates, sudden shifts take place, and heavy and confused seas break. It is obvious that the nearer the vortex is approached the quicker the shift of wind will be, and *vice versa*.

The *centre of the storm* is most likely to be different at various times; but it is certain that, in some cases, a certain interval occurs, and this is of considerable extent; while in others it has been thought that there is no calm or open space free from impetuosity. At all events, it must naturally be supposed, that the nearer the proximity of the centre the greater must be the force of the wind, and its more quickly shifting its direction.

Lieutenant Evans remarks that, "When fairly under the dominion or power of the storm, and in any part of the area, except in the immediate vicinage of the centre of rotation, a ship will not be liable to be taken aback; because, if scudding, she would not intersect the wind; and, if she be lying-to, it will either break her off or draw aft gradually, according to the

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* In connection with barometric changes, we may here advert to the constitution of the atmosphere, as mentioned on page 180. To that statement we will add the conclusions arrived at by Professor Dové, of Berlin, from his observations. In the northern hemisphere, *the barometer* falls during E.S.E. and East winds, passing from falling to rising during S.W., rises with W.N.W. and North, and has its maximum rise with N.E. wind.

The *thermometer* rises with E.S.E. and South winds, has its maximum with S.W., falls with W.N.W. and North, and its maximum at N.E.

The *elasticity of vapour* increases with E.S.E. and South winds, has its maximum at S.W., and diminishes during the wind's progress by West and N.W. to North; at N.E. it has a minimum.

tack she is on; but the case may be different under certain circumstances. Most ships are dismasted at the *crisis;* that is to say, at the time the wind *blows strongest*, which is always on the nearest approach from the centre to any given position. The point at which the wind of the hurricane *commences*, if observed, will make known to the observer the verge under which he is placed.

(115.) Prognostics.—With that threatening aspect of the sky which generally precedes all storms—such as the greasy halo round the sun or moon, the rolled and tufted forms of the clouds, with the lurid streaks of light and extraordinary colours, and the heavy bank clinging to the horizon with its darting forks and threads of pale lightning—every seaman is acquainted. The best and surest of all warnings will, however, be found in that invaluable, and seldom-failing monitor, the *barometer;* the language of which, in the torrid zone, is unmistakeable, because there it is usually tranquil and undisturbed. When any such warning symptoms are observed, in *any* quarter of the world, it may be supposed that no time should be lost in making all due preparation, and especially if to such menacing appearances be added the confused and troubled agitation of the sea which often precedes these revolving storms, and always shows that they are at no great distance. But if these combined prognostics should occur within the limits of *those regions* in which these cyclones occur, let the seaman immediately consider the possibility, at least, of his being about to encounter a storm of that revolving type of which we have been treating.*

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* Although it is true that the prognostics of a common coming storm are, in general, sufficiently plain to be understood by a spectator, from the angry appearance of the firmament, yet it is also true that there is no particular indication in any one quarter of the horizon sufficiently marked, like the space occupied by the *Black Squall* panoply of the Caribbean Sea; so that an acute seaman shall say, "thence will the blast come." On the contrary, the clouds gather together (we speak from experience) in dense masses, of a cinereous hue, in every direction, until the whole canopy of heaven is overspread, and the gloom at last becomes so intense that, even at mid-day, to speak within bounds, beyond a quarter of a mile no object can be even indistinctly seen. There are, however, some degrees of variation in the intensity of the obscurity; but we all know that the measure of distance by the eye upon such an exciting occasion is not likely to be very exact; at one period in a hurricane, just as the ship was dismasted, at the *crisis*, near noon, we could not clearly distinguish the end of the bowsprit from the quarter-deck—*Lieutenant Evans.*

Regarding the weather which accompanies those cyclonic storms which cross the British Isles (see p. 249) the Hon. Ralph Abercromby has carefully studied the weather charts issued by our Meteorological Office, and given his conclusions in a paper read before the Meteorological Society of London in November, 1877, as follows:—In a cyclone, the broadest feature of the weather is an area of rain about the centre surrounded by a ring of cloud, outside which the sky is clear. The precise form and position of these areas vary with the type of pressure distribution, with the intensity (wind force) of the cyclone, and the rate of its progress; they are also influenced by local, diurnal, and seasonal variations. In anti-cyclones, synoptic charts show great irregularity in the position of cloud, &c.

It might obviously be expected that the weather in any part of a large cyclone, as for instance, in one of those which completely crosses the Atlantic Ocean, would be very different from the weather in a small cyclone which perhaps only just crossed the British Isles, and this is fully borne out by observation. In very large cyclones, the steepest gradient, and the bad weather which accompanies them, are always found at some distance

(116.) Acting under this anticipation, his first care should be to discover the position of the storm with respect to the vessel, or, in other words, to ascertain its bearing. Fortunately this is a problem of extreme facility, for, as we have already stated, it is one of the remarkable laws of these storms that in opposite hemispheres they revolve in opposite directions—in *North* latitudes *against* the course of the sun, that is to say from *right to left*, or in a direction contrary to the movement of the hands of a watch; and in *South* latitudes from *left to right;* and, secondly, it is known that, no matter how great or how little may be the size of the storm-field, the wind continually blows in a circular course round and round a centre or vortex. It therefore necessarily and demonstratively follows that this centre must always be at right angles to that circular course; or, in other words, that the bearing of the centre lies eight points of the compass from the direction of the wind. Now, these two considerations are quite enough for our purpose, for they enable us to answer the question instantly and certainly by the following general rule :—

(117.) **Rule.**—Look to the wind's eye—set its bearing by the compass—take the eighth point to the **RIGHT** thereof—and that will be the bearing of the centre of the storm if in North latitude; or, if in South latitude, the eighth point to the **LEFT** of the direction of the wind.* For example: suppose the vessel to be in 14° N. latitude, the wind from E.S.E., and the barometer and sky indicate a coming gale—then look at the compass, take the eighth point to the right of E.S.E., and S.S.W. will infallibly be the bearing of the brewing storm, *if it be* of a revolving type; or, under similar appearances of the weather in 14° S. latitude, with the wind S.W., take eight points to the left of S.W., and S.E. will consequently be the direction of the centre of the impending gale. In the former case, the vessel will be on the northern edge of the storm-field; and, in the latter, she will be somewhere in its north-western segment.

(118.) In order to simplify this subject, and render it perfectly clear, a copy of the figure on p. 268, by the late Lieutenant Evans, who wrote on this subject under the name of "Stormy Jack," may be drawn on thick paper or card-board. The outer circle to be *fixed*, representing the points of the horizon; the inner circle, with index, to be moveable, and attached, with a button in the centre, so as to revolve on the outer or under circle; thus the inner circle may represent the *phases of the wind*, as it gyrates round a centre; the arrows showing the revolution of the æriel current from right to left. The moveable circle is sub-divided into four quadrants, for the purpose of facilitating the mode of operation.

Here (says Lieutenant Evans) it will be obvious that, if a vessel be caught under the N.N.W. verge of the hurricane, the wind, as shown by the arrow

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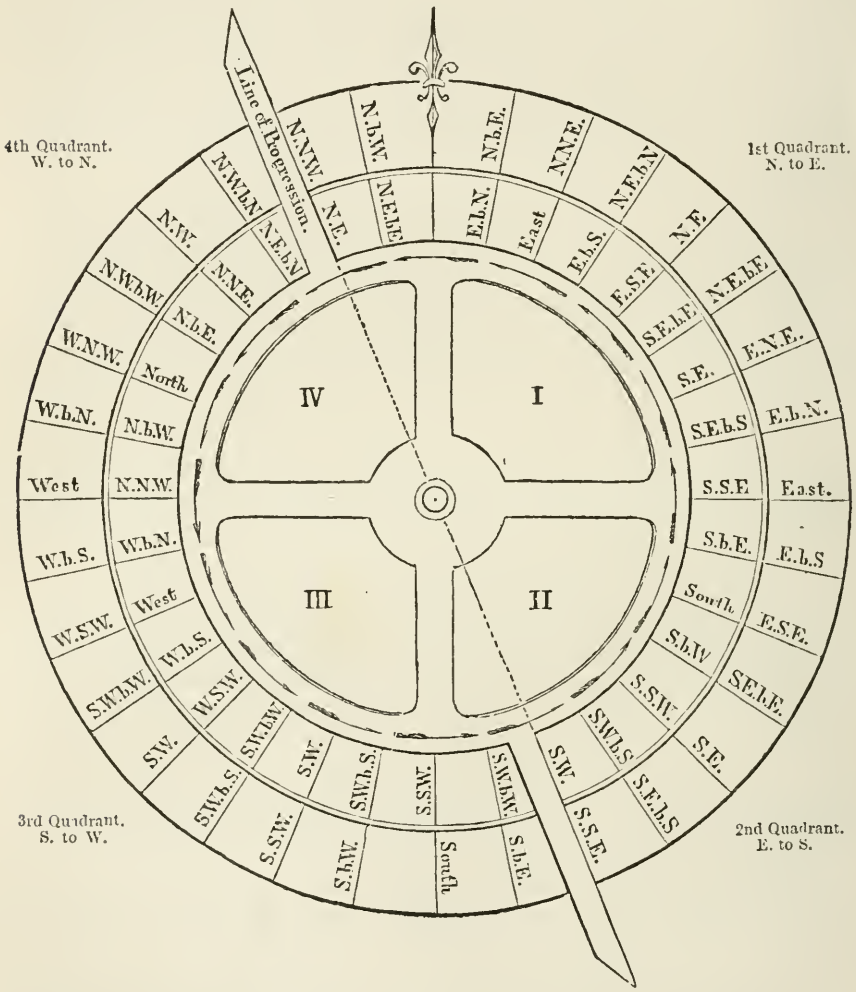
from the centre. Round the centre itself, when the gradients are very steep, the sky is broken with hardish clouds, and there is a cold pleasant feeling in the air. In small cyclones the heaviest rain usually surrounds the centre, and extends more or less to one end or the other, according to the direction of the nearest area of high pressure, and the steepest gradient.

* This rule of course can only be considered approximate, as the wind does not always blow round in a perfect circle, see (104) page 260.—Ed.

annexed to that point, will be, apparently, from E.N.E., and the changes will be seen as they occur progressively. On the N.E. verge of the hurricane the wind will appear to come from the S.E. On the North verge the wind will be East; and if on the West, it will be northerly, as shown in the figure.

The subject, when considered, will be readily understood; only bearing in mind that the shifts of wind will appear, *in most cases*, to be from left to right, *while the general wind is actually pursuing quite a contrary direction.*


Line of Progression.
4th Quadrant. W. to N.
1st Quadrant. N. to E.
3rd Quadrant. S. to W.
2nd Quadrant. E. to S.
IV
I
III
II
N.N.W.
N.b.W.
N.E.
N.E.bE.
E.b.N.
East
E.b.S.
E.S.E.
S.E.bE.
S.E.
S.E.bS.
S.S.E.
S.b.E.
South
S.b.W.
S.S.W.
S.W.bS.
S.W.
S.W.bW.
W.S.W.
W.b.S.
West
W.b.N.
N.N.W.
N.b.W.
North
N.b.E.
N.E.
N.E.bE.
E.N.E.
E.b.N.
East.
E.b.S
E.S.E.
S.E.bE.
S.E.
S.E.bS
S.S.E.
S.b.E.
South.
S.b.W
S.S.W.
S.W.bS.
S.W.
S.W.bW.
W.S.W.
W.b.S.
West
W.b.N.

E.N.E.; then move the upper circle in the line of progression to the N.W., which is the general line pursued, and the changes of the wind will be seen as they occur on the object marked.

The direction of the wind is independent of the progression of the storm; and as the current of air, whilst sweeping round the centre, pursues one unvaried path, it follows that, under every point of the horizon, there will be experienced a wind blowing at right angles to it, unchangeable in its direction; thus, under the *North* point of the horizon, there will be an East wind; under the *South* point, a West wind; and under the East point, a South wind; so that, were the storm stationary, a ship scudding round the entire circle, from any given position, would experience the wind from every point of the compass in regular succession; but this, as the fact is, can very rarely, if ever, happen, on account of the progressive movement of the entire meteor.

As these storms do not pursue a uniform velocity, the rate of their actual progression can be arrived at only after they have ceased to act on any two or more stationary spots, or upon two ships, by noting the exact time each experienced the first shock of the hurricane, and also the time of its departure repectively. Some cause, or causes, operate to accelerate the rate at one time, and retard it at another

On reference to the preceding diagram, it will be seen, that if a ship first encounters a hurricane with the wind at E.N.E., she will be under the N.W. verge; and as the progression is (generally) to the N.W., the changes of the wind will be to the eastward, going round to the S.E. and South, and ending with it at about S.W. by S. *Apparently* these changes will be from right to left.

It becomes necessary here to observe that, although the general medium course of the hurricane in the West Indies has been found to be N.W., yet in two or three instances we have reason for believing that either a deviation in particular parts of its course, or otherwise, a vibration or oscillation of the entire meteor, has taken place. Any deviation, however, from the general course pursued by the storm to the N.W. can easily be detected, from the veering of the wind; as that ought to be regular, when the progressive path of the storm is regular, except at or near the vortex. For instance, if the hurricane commences at E.N.E., and the wind does not follow the regular successive changes, as noted above, we may be assured that the storm is not pursuing a course to the N.W.; and the true line of progression may be ascertained by the circle, so as to gain the corresponding points of change to those which occur.

(120.) Again, if the storm commences at North, the wind ought to veer (under the same progressive direction of N.W.) to the N.W., West, and end with it about W. by S. or W.S.W. But, if after the wind has got to West, the storm should end with it at South as it did at Antigua, 1804), we shall be assured that a deviation had taken place to the westward in the progression, or otherwise a vibration or oscillation to the southward.

The uncertainty of these aberrations should not deter the navigator from placing confidence in the general remarks here given, as these (based on Mr. Redfield's theory) have been arrived at from experience, from facts

which are incontrovertible, and from a careful study of the subject; and besides, should these variations not happen, and to a certainty they do not always occur (at least on the ocean), he may benefit by them; whilst, under a case of their occurrence, no rules can possibly be given for his guidance; he must place his vessel in the best position his judgment points out, and passively await the result.

We shall now endeavour to explain, in the plainest manner we can, the operation of the wind, and its effect on a vessel in each of the quadrants, when the progression is to the N.W.

(121.) *First, or N.E. Quadrant.*—Wind from South to East. The changes of wind, if a vessel be lying to, will *appear* to take place from *left* to *right*, throughout; as the wind will *seem* to draw round them from the eastward toward the South, although it is in fact proceeding the contrary way, or from right to left.

The navigator's attention is particularly directed to this apparent paradox; for, whilst he notes the wind down in his journal as veering with the sun, it is all the time, as remarked before, going the contrary way. The delusion is occasioned by the progression of the hurricane to the N.W., which, by receding from the vessel's position, has the effect of bringing up the more southerly *phases* of the wind in succession, and consequently, imparting to these an *apparent* contrary direction to that which the whole current of air is actually pursuing. This deceptory process is somewhat similar to the well-known astronomical illusion every day before our eyes; we allude to the apparent course of the great luminary. Not only can we imagine, from the evidence of our sense of seeing (not at all times to be depended upon), that the sun is moving from East to West, but, in common *parlance*, such an idea is invariably expressed; yet everybody knows that this is only apparent, and that the delusion is occasioned by the diurnal rotation of the earth round its exis from West to East.

This point, however, once clearly understood, will no longer perplex us, and the best mode to adopt, in order to avoid being puzzled, is to use the moveable circle with the *phases* of the wind marked on the rim, placing it over the fixed circle with the points of the horizon marked to represent the ocean.

We now proceed with the first quadrant. If a ship scuds to the northward, the direction of the alteration of the wind will in a great measure depend upon her velocity, as she is crossing obliquely the course of the progression: if she keeps pace with the *northerly* advance of the storm, the wind will remain the same; if she exceeds it, the wind will draw round to the eastward; and if the progression outstrips her, the changes will be to the southward. In either of the latter cases the variations will be few, in all probability; and the westerly progress may be expected to cause the ship to be speedily thrown out of the circle of operations.

A ship is likely to enter this quadrant only under the northern verge from the North to the N.E. point: if she happens to be standing to the southward, within the limits of the Trade wind, she will be liable to be taken aback; but if nothing to the northward, of course she will not.

(122.) *Second, or S.E. Quadrant.*—Wind from West to South. A ship lying-to, with the wind from any point between South and S.W., the shifts

will be from the southward toward the West, *apparently* from left to right. If the wind be between the S.W. and West, there will be few if any changes, as the ship will be near the posterior line of the progression; what changes may happen will probably be from West towards the South. The vessel will soon be clear of the commotion. It seems pretty evident that a vessel will not, in the first instance, be liable to fall under the S.E. verge in this quadrant, for this reason—that she cannot overtake the hurricane, as its velocity, in all probability, at any time would exceed her rate of sailing. She may, however, just touch literally about the southern verge, where she should get the wind from the West. To enter this quadrant, therefore, a ship must pass through some other.

(123.) *Third, or S.W. Quadrant.*—Wind from North to West. A ship lying-to, the wind from the northward (as the storm progresses) will draw round to the westward, from right to left, truly as apparently so.

As a ship scuds to the southward and eastward, the wind will draw round in the same manner as mentioned above. It appears obvious, that a vessel falling into the storm, under any point in this quadrant, would merely feel the "*brush*," but she will be liable to be taken aback if standing to the northward or north-eastward on first entering the scene of operation, supposing her to be within the limits of the Trade wind.

(124.) *Fourth, or N.W. Quadrant.*—Wind from East to North. If a ship lies-to with the wind at any point between East and N.E., it will *appear to* draw round from left to right, or from N.E. by E. to East. If she lies-to with the wind between N.E. and North, the shifts will be from right to left, or from N.E. by N. to North. Under the N.W. verge (where the wind is at N.E.), a ship, being then in the line of the anterior progression, will drift, probably, into or very near to the centre of the circle, which, on account of the sudden shifting of the wind there, should, if possible, be avoided, as there the greatest danger may correctly be considered as existing.

If a ship scuds, under the same circumstances of winds, the changes will appear the same as above given; but slower in the first instance, and quicker in the second, for these reasons: that in the one case, the points of change are receding from her as she advances; and in the other, they draw toward her approach, her velocity through the water accelerating the alterations; and this difference is occasioned by the progression to the N.W.

Within the limits of the Trade wind, if a ship be standing to the southward, she will not be liable to be taken aback, on striking the storm in this quadrant, but she would be so if veering to the northward.

It should be constantly held in remembrance, that, under all circumstances, the wind remains the same; or, in other words, that under any given point of the horizon, the wind will be found to blow from a particular direction unchangeable, so that there is actually no shifting; the changes observable being occasioned by the progression of the storm to the N.W., and the movements of a vessel.

From this peculiar character of the tempest, the course which a ship will pursue through the circle of operations, as also the successive changes of the wind, as these appear to take place, become an easy problem to solve, after having noted the point from which the first wind or the first shift, if felt

(*provided* no divergency in the course, or vibratory motion of the meteor) takes place.

Although a ship, in most cases, we imagine, may be more likely to fall into the circle of operations under the north-western verge of the storm than in any other part, as that is the anterior advancing section, no general rules can be laid down for the guidance of the mariner for placing his ship in such a position so as to ensure her not being taken aback when the storm shall be first felt, because until that moment arrives, when the direction of the first blast is to become his "polar star," he cannot, with unerring certainty, anticipate his position with respect to the particular verge of the hurricane that is approaching him.

Under such unavoidable circumstances, he must use his best judgment in preparation for meeting the worst, and be ready to lay his vessel to, or to scud, according to the direction of the wind first experienced. To be quite sure of what he is about to do, perhaps the safest plan would be to wait until the first *shift* takes place after the commencement of the storm; by which measure his position would be confirmed, a point of material consequence to arrive at.

Every experienced seaman, after having given the theory his best attention, and made himself familiar with the whole working of the wonderful meteor, will of course follow the dictates of his own nature and judgment, upon an occasion that will assuredly call forth the full exercise of it. Without, therefore, presuming or desiring to obtrude upon him the manner we ourselves should act under a case of such uncertainty, which would demand all the resources of mind of the individual commander, for the first time placed in such a dilemma, we shall nevertheless offer it here as a mere illustration.

Let us, then, suppose that we are steering to the northward in our ship, within the limits of the Trade wind (call it E.N.E.), and that certain prognostics appear, which our judgment informs us forbode a storm. If it happens to be the hurricane season, we are bound by prudence to prepare the ship for encountering a tempest of that nature, even though appearances may induce us to think that such would not eventually happen; for, whether a mere common gale or a hurricane should follow, every sensible person will admit that, during that season, it is the wisest as it is the safest plan, to be prepared to meet the worst that may happen under such appearances. It must be recollected that nature herself proclaims the warning, and her admonitions are not to be disregarded with impunity.

Without loss of time, we make the ship snug, hatches battened down, &c. This done, we should bring her to the wind on the starboard tack, with her head to the northward, with a fore and a mizen storm stay-sail. We cannot, as we said before, anticipate under what verge of the storm we shall enter, but we shall have done all that prudence can dictate, by lying-to *without square sails*, and of course making our minds up to have the fore-and-afters blown to shreds by the new wind, come from whatsoever quarter it may. In this position we must wait patiently until the first shift of wind takes place. If this should be from E.N.E. to E. by N. and East, we should make ourselves easy in the position obtained, with reference to the particular verge of the storm, as well as in what we had placed the ship; having the

assurance (from the shift of wind) that the anterior verge which had struck us, would be now running away at the rate of from 15 to 20 miles an hour, whilst our drift to the westward would not exceed 3¼ miles in the same time; so that every point that the wind drew round toward the South, would tell as plainly as if a map of the whole operations were suspended in the heavens overhead, for our consolation, that our exit from the commotion was rapidly drawing nearer and nearer; and that, if the ship proved equal to contend with the *crisis*, and no vibration occurred, we should escape the centre.

This may sound, in the style of the celebrated Francis Moore, of predicting memory, very like "taking a peep into futurity." We are, not, however, studying the doctrine of probabilities. As far as we at present know of the matter, and (thanks to Mr. Redfield) we have gained a pretty general insight into it, there appear but two circumstances, at all likely to upset our calculations and foresight of w. at is to happen, and these are, as intimated before, a divergency in the line of progression, or a vibration of the entire meteor; and here we are taught, that, with all the wide and searching capacity of our minds, there is a point beyond which it is not permitted man to peer. We have been allowed, however, to glean enough of the economy of this wonderful phenomenon to excite our unfeigned gratitude to HIM "who rules the whirlwind and the storm." We proceed—

On the other hand, if the shift of wind was to the N.E., or even a point on either side, we should immediately know that we were in the very jaws of the lion;" and to escape being overwhelmed in the vortex we must run for it.* On this occasion, every moment is of importance, when we bear in mind that we are now in the path which the centre will follow. To the S.W., therefore, we start away, not without an impressive dread, as the wind comes veering round and round toward the North, of a too close approximation to the vortex, toward which curve the ship makes inclines. If we could tell the exact diameter of the hurricane, and its precise rate of progression, we could calculate pretty accurately whether, and at what distance, we should pass the centre; but as these data can never be obtained, we have nothing otherwise than *prudence* to guide us in this particular case, the most perilous that can occur.

There is a very nice point to be determined upon at this juncture, and one, although there will be but a few minutes for decision, that should not be rashly settled; a sort of choice between the scalping-knife and the tomahawk—a very forlorn hope, take which measure you please—it is this; to scud under square sail, or to run with bare poles? Now, however desirable it is that top-sail should be carried in a storm where the waves rise to a great height, and break in heavy surf, and a ship's way is lessened as she drops into the trough, to prevent her from being pooped, yet, we say, although it should be practicable to set a close-reefed main-topsail, the propriety of so doing is questionable until the wind has drawn round to the westward of North (and then it might as well be left alone), for not before

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* When the line of progression is to the W.N.W. (a direction which some of the most southern storms have pursued), it would be wrong to scud with the wind at N.E.; but when at N.N.E., it would be proper to do so.

that will the dreaded centre have been passed; and as there can be no certainty of a ship's safety until that "consummation" has been accomplished, the chance of being taken aback with square sail deserves the most serious consideration of the commander. The danger in both cases is imminent; but, in determining for ourselves, we should run with bare poles, until finally thrown out of the storm. Indeed, after all the judgment, care, anxiety, and apprehension which may be displayed and felt on so trying an occasion, our approximation, notwithstanding the vessel's *dash* of 12 or 13 knots, may be so near the vortex as that every stick shall be blown out of her. And we impressively declare our conviction, that hitherto the majority, if not all, the vessels that have been lost in hurricanes and typhoons, have foundered by falling into the centre with square sail set whilst scudding. On lying-to, no sail would stand the disruptive puffs for five seconds!

We have ourselves, in utter ignorance of the operations as they occur, and are here stated, been scudding in a frigate, partly dismasted, with reefed *main-sail* (the only sail available), before the furious blast of a hurricane, after the wind had veered to the S.W. As it happened, we had fortunately dropped into the second quadrant, and were drawing near our exit, but we knew nothing of that; and if it had happened in the fourth quadrant, and we had got into the centre, there is no doubt but that the ship must have foundered! But to proceed:—

No other resource is available to us under such circumstances as described above; and no other alternative remains except the desperate one of heaving-to, defying the fury of the storm, and taking the chance of being thrown directly into the centre of commotion; where, if the ship could not founder, she would, there is scarcely a doubt, lose her masts, and be otherwise completely assailed at all points by the raging elements!

The N.W. verge of the hurricane, whilst it advances in that direction, is the "very head and front" of the danger, the nucleus of which follows, in a direct line, the advance of that point. The consequences, be they the foundering of the ship, or the loss of her masts, &c., are inevitable, if prompt and active measures are not taken to get out of that position.

Should the wind, at first, keep steady at E.N.E. for some time, which it would do (if the storm is of great extent) when a ship enters under the N.N.W. verge, the navigator may be a little puzzled how to act, as anticipating a shift, to determine his position; he need be under no apprehension; the shift will come in due time (according to the extent of the circumference) from the E. by N., and so gradually round (but quickening as he approaches the centre) to the southward: he may, however, expect to lose some of his spars when the *crisis* arrives.

We have dwelt longer upon the action of the wind in the fourth or N.W. quadrant, because under this anterior verge the greatest peril may follow; and we may now be permitted to express a hope that mariners may derive some little advantage from the perusal of this paper, as the writer has devoted his best attention to the subject with the sole view of rendering them, as brother sailors, a service. JOHN EVANS.

(125.) We will close this portion of our remarks with some general observations on the subject by *Captain Richard Leighton*, of Montrose to whose

kindness and talent we are indebted for numerous additions to hydrography:—

"1st. Outward-bound ships. As the S.E. storm-wind is generally nearly directly in front of the storm, on meeting with that wind and a falling barometer, &c., you should bear off freely to the north-westward, that is, nearly at right angles with the route of the gale, and all that you run that way will increase your distance from the centre when it passes you; whilst, if you run westward, you will pass so near to the centre that you will be taken aback by the wind flying into the north-westward; the object is to skirt the gale, and haul more westerly as the wind veers to the eastward.

"2nd. When the wind is to the southward of S.E., it appears that you must pass through the right-hand semicirle, and should haul-to and hold all the southern that you can; lay down the bearing and distance of the centre, and as soon as practicable, by a second bearing and distance, estimate the route of the gale and its progress.

"3rd. Estimate your distance, and the course that you are likely to make, clear of leeway, and some veering in the wind, and this will give you an idea at what distance you are likely to pass the centre, and what is likely to occur. Knowledge is power. Most carry sail long enough, but many don't set it *soon enough*.

"4th. The further the wind is to the southward, the nearer you must pass to the centre, and as the wind veers and breaks her off, she will lay in the trough of the sea, and is most likely to get damage that way, so that if the wind gets loose, it is time to be upon the right tack (that is, the starboard tack, with westerly winds, in the Atlantic, being in the right-hand semicircle). Every one knows best what his own ship will bear, and what she will perform; however, if you *will go ahead* till the last minute, when the *barometer stops falling*, it is *high time* to have her round upon the right tack, as there is generally a tremendous gust shortly after the barometer stops falling; or, when it has made a slight rise, and the ship should be upon the starboard tack, that she may *come up* and bow the sea when she takes it.

"5th. To wait for 'the lull,' or the 'sky to the westward lighting up, to indicate the shift,' will often be *too late*.

"6th. Eight miles per hour, I think, is a fair medium for the rate of progress of rotatory gales in the Atlantic and Southern Indian Oceans. The regular West India cyclone travels generally much quicker, and some Mauritius cyclones have a very slow movement; that which the *Charles Heddle* scudded three and a half times round, only progressed about 2½ miles per hour. *At Sea, August*, 1851.—R. Leighton.

(126.) **EXAMPLES.**—To illustrate the preceding remarks and directions, accounts of a series of revolving storms is given. They are illustrated by the map before alluded to at the commencement of this section.

Routes on the Chart.—No. I. Trinidad to Yucatan, over the middle of the Caribbean Sea, June 23 to 28, 1831.

No. II.—Barbadoes to the Mississipi, August 10 to 17, 1831.

No. III. Guadaloupe to the Bank of Newfoundland, August 17 to 29, 1827.

No. IV. Guadaloupe and Antigua to Charlestown, and thence to the Bay of Fundy, September 3 to 10, 1804.

No. V. Antigua, passing over Cuba, to the coast of Texas, August 12 to 18, 1835.

No. VI. Barbuda to Charlestown, and thence to the Bank of Newfoundland, August 12 to 19, 1830.

No. VII. From the intersection of 20° North and 60° West (N.E. of Barbuda), passing to the West of Bermuda, and thence N.E. to the parallel of 42½°, September 29 to October 2, 1830.

No. VIII. From the parallel of 22° (North of Porto-Rico) to Cape Hatteras and the coast of Maine, September 1 to 5, 1821.

No. IX. From near the same spot as No. VIII., on a similar route, but more to the eastward, August 22 to 27, 1830.

No. X. From the parallel of 30° North, on the East side of the Florida Stream, to Cape Sable of Nova Scotia, January 13 to 16, 1831.

No. XI. Inland storm, over the lakes, and thence to the Gulf of St. Lawrence, November 10 to 12, 1835.

The route designated as No. I. is that of the hurricane which visited the Islands of Trinidad, Tobago, and Grenada, on the 23rd of June, 1831. Pursuing its course through the Caribbean Sea, it was subsequently encountered by H.M. schooner *Minx*, and other vessels, and its swell was thrown with great force upon the south-eastern shores of Jamaica on the 25th, while passing that island, where the wind at this time was light from the northward. After sweeping through the Caribbean Sea, the hurricane entered upon the coast of Yucatan, on the night of the 27th, having moved over the entire route from Trinidad to the western shore of the Bay of Honduras, in a little more than 100 hours, a distance of nearly 1,700 miles, equal to 17 miles an hour.

Track No. II. is that of the hurricane which desolated Barbadoes in the night of the 10th of August, 1831; and which passed Porto Rico on the 12th; Aux Cayes, in Hayti, and S. Iago de Cuba, on the 13th; Matanzas on the 14th; was encountered off the Tortugas on the 15th; in the Mexican Sea on the 16th; and was at Mobile Pensacola, and New Orleans on the 17th; a distance of 2,000 miles in about 150 hours, exceeding 13⅓ miles an hour. Its course, until it crossed the tropic of Cancer, was nearly W.N.W. Mr. Redfield adds—"In pursuing its northern course, after leaving the ocean level, it must have encountered the mountain region of the Alleganies, and was perhaps disorganised by the resistance opposed by these elevations It appears, however, to have caused heavy rains in a large extent of country north-eastward of the Mexican Sea."

Track No. III. is that of the destructive hurricane which swept over the Windward Islands, 17th August, 1827; visited St. Martin and St. Thomas on the 18th; passed the N.E. coast of Hayti on the 19th; Turk's Islands on the 20th; the Bahamas on the 21st and 22nd; was encountered on the coast of Florida and South Carolina on the 23rd and 24th; off Cape Hatteras on the 25th; off the Delaware on the 26th; off Nantucket on the 27th, and off Sable Isle and Bank on the 28th. Its ascertained course and progress were nearly 3,000 miles in about eleven days; or at the average rate of about 11 miles an hour. The direction of its route, before crossing the tropic, nearly N. 61° W., and in lat. 40°, while moving eastward, N. 58° E.

Track No. IV. An extensive hurricane of September, 1804, which swept over the Windward Islands on the 3rd of that month; the Virgin Islands and Porto-Rico on the 4th; Turks' Islands on the 5th; the Bahamas and the Strait of Florida on the 6th; the coast of Georgia and the Carolinas on the 7th; Chesapeake and Delaware, with the continuous portions of Virginia, Maryland, and New Jersey, on the 8th; and the States of Massachusets, New Hampshire, and Maine, on the 9th; being on

the high lands of New Hampshire, a violent snow-storm. The destructive action of this storm was widely extended on both sides of the track indicated upon the chart, and the same fact pertains in a greater or less degree to the other storms herein mentioned. It appears to have passed from Martinique and the other Windward Islands to Boston, by the usual curvilinear route, in about six days a distance of more than 2,200 miles, at an average progress of about 15½ miles an hour.

Track No. V. The route of the hurricane which ravaged Antigua, Nevis, and St. Kitt's, in the afternoon and night of August 12th, 1835; St. Thomas, St. Croix, and Porto-Rico, on the 13th; Hayti and Turks' Islands on the 14th; the vicinity of Matanzas and Havana on the 15th; was encountered off the Tortugas, on the Bank of Florida, on the 16th; in lat. 27° 21′, long. 94°, and other points on the 17th and 18th; and at Matomoras, near the Mexican shore, lat. 26° 4′, on the 18th, where it was most violent during the succeeding night. It also passed over Galveston Bay, in Texas, and there blew with violence from the S.E.; while at the mouths of the Mississippi and along the northern shores of the gulf, the gale was not felt. This storm is remarkable, as moving more directly and further to the West than is usual for storms which pass near the West Indian Islands, it having reached the Mexican shores before commencing its sweep to the northward. Course about N. 73° W.; progress more than 2,200 miles in six days; nearly equal to 15½ miles an hour.

Tract No. VI. The memorable gale of August, 1830, described hereafter, which, passing close by the Windward Islands, visited St. Thomas on the 12th, was near Turks' Islands on the 13th; at the Bahamas on the 14th; eastern coast of Florida on the 15th; coasts of Georgia and the Carolinas on the 16th; off Virginia, Maryland, New Jersey, and New York on the 17th; off George's Bank and Cape Sable on the 18th; and over the Newfoundland Bank on the 19th; having occupied about seven days in its ascertained course from near the Windward Islands, a distance of more than 3,000 miles; the rate of its progress being equal to 18 miles an hour. If, adds Mr. Redfield, we suppose the actual velocity of the wind, in its rotatory movement, to be five times greater than this rate of progress, which is not beyond the known velocity of such winds, it will be found equal, in this period, to a rectilinear course of 15,000 miles. The same remark applies, in substance, to all the storms which are now passing under review.

Track No. VII. was encountered to the northward of the Caribbee Islands on the 22nd of September, 1830; its route was to the eastward of all those previously described, and was found on the Grand Bank of Newfoundland, October 2, having caused great damage and destruction on its widely-extended track, to the many vessels which fell in its way. The ascertained route may be estimated at 1,800 miles, and the average progress 25 miles an hour.

Track No. VIII. experienced in September, 1821, as more fully shown hereafter. This hurricane was extremely violent; it was encountered to the north-eastward of Turks' Islands, on the 1st of the month; to the northward of the Bahamas and near the latitude of 30° on the 2nd; on the coast of the Carolinas early in the morning of the 3rd; and from thence, in the course of that day, along the coast of New York and Long Island; and it is represented to have continued its course across the States of Connecticut, Massachusets, New Hampshire, and Maine. The diameter of the storm appears to have exceeded 100 miles; its ascertained route and progress about 1,800 miles in sixty hours, equal to 30 miles an hour.

A similar but less violent storm swept along the same portion of the coast of the United States on the 28th of April, 1835.

Track No. IX. The route of a violent and extensive hurricane, which was encountered to the northward of Turks' Islands, August the 22nd, 1830; northward of the Bahamas on the 23rd; and off the coast of the United States on the 24th, 25th, and 26th of the same month. It produced much damage, but scarcely reached the

American shores. Its duration was about forty hours, and progress more tardy than some others.

Track No. X. A violent hurricane and snow-storm, which swept alongthe American coast from the parallel of 30° North, on the 5th and 6th of December, 1830. This track corresponds to another storm of similar character, which swept along the coast on the 13th, 14th, and 15th of January, 1831. These violent winter storms exhibited nearly the same phases of wind and general characteristics as those which appear in the summer and autumn.

Track No. XI. The violent inland storm which passed over the Lakes Erie and Ontario on the 11th of November, 1835. This storm was very extensive, spreading from the sea-coast of Virginia into the Canadas, to a limit unknown. The anterior portion of this gale was but moderately felt, and its access was noted chiefly by the direction of the wind and the great fall of the barometer; the violence of the storm being exhibited chiefly by the posterior and colder portion of the gale, as is common with extensive overland storms. The regular progression of the storm, in an easterly direction, was established by facts collected by Mr. Redfield, from the borders of Lake Michigan to the Gulf of St. Lawrence and the coasts of New England and Nova Scotia.

In pursuing the descriptions above, it is to be noted that the lines on the chart representing the routes, are given by Mr. Redfield as but approximations to the centre of the track or course of the several storms; and the gales are to be considered as extending their rotative circuit from 50 to 300 miles or more, on each side of the delineations; the superficial extent of the storm being estimated both by actual information and by its duration at any point near the central portion of its route, as compared with its average rate of progress.

The circular figure which appears upon the Chart, on Tracks Nos. I., V., and VII. will serve, in some degree, to illustrate the course of the wind in the various portions of the superficies covered by the storm, and also to explain the changes in the direction of the wind, which occur successively at various points, during the regular progress of the gale.

(127.) *The Great Hurricane*, which commenced at Barbadoes on the *10th of October*, 1780,* was preceded in the evening of the 9th by weather remarkably calm, but the sky surprisingly red and fiery, and during the night much rain fell. The storm approached from the S.E., and the ships of the squadron stationed here experienced the hurricane, each in turn, according to the place she was in. A letter from Dr. Blane, dated from the *Sandwich*, Sir George Rodney's flag-ship, stated that it was not previously apprehended that there would be anything more than such a gale as they experience from time to time at that season; but, on the evening of the 10th, the wind rose to such a degree of violence as clearly to amount to what is called a *hurricane*. At eight p.m. it began to make an impression on all the houses, by tearing off the roofs, and overthrowing some of the walls. As the inhabitants had never been accustomed to such a convulsion of nature, they remained for some time in security, but they now began to be in the utmost consternation. * * * * It was thought to be at its greatest height at midnight, and did not abate considerably until eight next morning. During all this time, most of the inhabitants had deserted their houses, to avoid being buried in the ruins; and every age, sex, and condition, were exposed in the fields to the impetuous wind, incessant torrents of rain, and the terrors of thunder and lightning. Many were overwhelmed in the ruins, either by clinging for shelter too long in the buildings, or attempting to save what was valuable, or by unavoidable accidents in the fall of walls, roofs, and furniture, the mate-

* The track of this hurricane is shown on the Chart, commencing between No. i. and ii.

rials of which were projected to great distances. Even the bodies of men and cattle were lifted off and carried above the ground. From an estimate of the number of deaths reported to the governor, they amounted to more than 3,000. All the fruits of the earth were destroyed; most of the trees torn up by the roots, and many of them stripped of their bark. The sea rose so high as to destroy the fort, carrying the great guns many yards from the platform, and demolishing the houses near the beach. A ship was driven on shore against one of the buildings of the naval hospital, which, by this shock, and by the impetuosity of the wind and sea, was entirely destroyed and swept away. * * * * The mole-head was swept away; and ridges of coral rock were thrown up to above the surface of the water; but the harbour and roadstead were, upon the whole, improved, having deepened in some places 6 feet, in others many fathoms. The crust of coral, which had been the work of ages, leaving a soft oasy bottom, and many shells and fish were found ashore which had been previously unknown.

The hurricane passed, in succession, over the Islands of St. Vincent, St. Lucia, Martinique, and Dominica, and included within its area those of Guadaloupe, St. Christopher, St. Eustatius, &c. At St. Vincent, every building was blown down, and the town destroyed. At St. Lucia, which was near the centre of the hurricane, all the barracks and other buildings were blown down and the ships driven to sea. At Martinique, likewise, all the ships that had brought troops and provisions were blown off the island. On the 12th, four ships with their crews foundered in Fort Royal Bay. The other ships were blown out of the roads. In the town of St. Pierre, on the N.W. coast, every house was blown down, and more than 1,000 people perished. At Fort Royal, the cathedral, seven churches, other religious edifices, many public buildings, and 1,000 houses, were blown down, as was the hospital of Notre Dame, in which were 1,600 sick and wounded, the greater part of which were buried in the ruins. The number of persons who perished in Martinique is said to have been 9,000. Dominica likewise suffered greatly, and Guadaloupe was within the northern verge of the hurricane.

At *St. Eustatius*, although not far within the N.E. verge, the loss was very great. On the 10th of October, at eleven a.m., the sky on a sudden blackened all round; it looked as dismal as night, attended with the most violent rains, thunder, lightning, and wind. In the afternoon the gale increased; seven ships were driven on shore near the North point, dashed to pieces on the rocks, and their crews perished. Nineteen vessels cut their cables and went to sea. In the night every house to the northward and southward was blown down, or washed away with the inhabitants into the sea, a few only escaping. The houses to the East and West were not so much hurt till the afternoon of the 11th, when the wind, on a sudden, shifted to the eastward; and at night it blew with redoubled fury, and swept away every house; but the forts, barracks, hospital, cathedral, and four churches remained. Here between 4,000 and 5,000 persons are supposed to have lost their lives.

Advancing north-westward, the centre of the hurricane on the 14th had reached to the Mona Passage, on the West of Porto Rico. Here the *Ulysses* and *Pomona*, with a fleet under their convoy, suffered greatly, and here the *Deal Castle* frigate was wrecked. Another frigate, the *Diamond*, fell within the western verge of the storm on the 15th, but happily escaped by passing Alto-Vela, on the South side of Hayti. Above the parallel of 20°, the *Stirling Castle* was lost on the Silver Kay Bank, and most of her crew perished. On the 18th we find, in about 22½° N., and 69° W., the *Trident*, *Ruby*, *Bristol*, *Hector*, and *Grafton*, men-of-war, on the S.W. verge of the storm. The ship last mentioned, on the 16th, at noon, was in lat. 26½°, long. (by estimation) 71° 30′; heavy gales and cloudy weather; lying-to under trysails; the gales split the sails to ribands. On the 18th, lying-to; strong gales and heavy squalls.—17th to 18th, carried rapidly to the south.eastward, when the *Trident*,

Ruby, and *Hector*, came in sight as above. At eleven a.m., spoke the latter, in great distress.

The *Ruby*, *Trident*, and *Bristol*, on the 15th, were as high as 27½° N., and they, too, from the western border of the hurricane, were driven to the southward, until they joined company.

Here the detail becomes imperfect, until we reach the Bermudas; but to the N.E. of these isles we find the *Berwick*, on the 19th, which had fallen, on the 17th, within the border of the hurricane from a position to the W.N.W., near the latitude of 35°. This ship had previously been one of Rear-Admiral Rowley's squadron; she was proceeding to England under jury-masts, and had reached to the North of the latitude of the Bermudas when the hurricane overtook her. On the 16th, at eleven a.m. during calm, there was a great swell from the eastward. On the 17th, at one p.m., she was taken aback; wore ship and handed topsails; at three, squally, with rain; loosed the topsails; six to eight, wind E. by N. fresh gales. On the 18th, winds variable from the eastward, E. by N. to E.S.E.; after midnight, strong gales and heavy squalls. At noon, by estimation, Bermudas S. 53° E., 31 leagues. 19th, at one a.m., weather moderate, and the ship proceeded on her course.

On the 18th about fifty vessels were driven on shore at Bermuda.

We have been the more particular in giving these details, from having formerly been misled by imperfect data. In the delineation of the "Great Hurricane," given by Colonel Reid, he first assumes a circle having a radius of about 170 miles, which gradually expands, on its N.W., North, and N.E. course, to 270, with, we may presume, a diminished and proportionate momentum, on the parallel of Bermuda. The colonel observes that, on reading the logs and the various accounts of this hurricane, and comparing the different reports of the wind, it will be found that no storm yet described, proves more strongly than this, the rotatory nature of hurricanes.

(128.) *Trinidad, June*, 1831.—(*No. I. on the Chart.*)—It will not readily be forgotten that, on the 23rd of June, 1831, Trinidad, in the parallel of 10½° N., experienced one of the most awful storms of wind and rain ever remembered by the oldest inhabitant. The gale commenced at five o'clock on Thursday morning, and continued till eleven. The wind, after shifting from East, North, West, and South, finally settled at S.W., and blew without intermission until three in the afternoon. Eleven or twelve vessels were driven on shore, and several of them severely damanaged.

It was subsequently stated that the hurricane was felt at all the southern islands, where the loss it occasioned was very great. Such a storm had not happened at Granada since the year 1780; the devastation was extensive and dreadful; and the loss in that colony was estimated at £80,000. Its course to Yucatan is described hereafter.

(129.) *Barbadoes, August*, 1831.—(*No. II. on the Chart.*)—In the night following the 10th of August, one of the most devastating hurricanes that had ever been experienced visited Barbadoes. Not a single house was left uninjured, and the greater part were levelled with the ground. On the 11h it passed over the Islands of St. Vincent and St. Lucia, extending a portion of its influence to Martinique and islands to the N.W.. and to Granada on the South, but exhibiting its principal violence between 12¼° and 14° N., or the parallels of Barbadoes and Martinique. On the 12th it arrived on the southern coast of Porto Rico; from the 12th to the 13th it swept over the South side of Hayti, and extended its influence as far southward as Jamaica. On the 13th it raged on the eastern portion of Cuba, sweeping in its course over large districts. The town of Aux Cayes, in Hayti, was almost destroyed by its force, and that of St. Iago de Cuba was very much damaged. On the 14th it was at Havanna and toward the West end of Cuba. On the 15th it proceeded north-westward, and on the 16th and 17th it arrived on the northern shoses of the Mexican Sea, in about the 30th degree of latitude, raging simultaneously at Pensacola, Mobile, and New

Orleans, where its effects were continued till the 18th. At New Orleans, on the 17th, it came on in dreadful gales, from N.E. to S.E., accompanied with torrents of rain. Almost all the shipping in the river were driven on shore, and very few of the smaller craft escaped total wreck. The back part of the city was completely inundated. The sugar-canes, above and below the city, were laid flat, and the loss was enormous. The gale was felt at Natchez, 300 miles up the river; and hereabout it spent itself in heavy rains, after having occupied a period of six days in the cycloidal course from Barbadoes.

At most of the islands, during the hurricane, the winds in the earlier part of the storm were from a northern quarter, and in its later periods from a southern quarter, of the horizon; from which it results, that the gyratory action was from *right* to *left*, as in the storms which pass to the northward of the great islands, and along the western coast of the ocean.

The distance passed over by the storm, in its passage from Barbadoes to New Orleans, is equal to 2,100 nautic miles. The average rate about 14 miles an hour.

(130.) *Hurricane of* 1830.—The storm which passed the city of New York, on the 17*th of August*, 1830, was there, and along all the coast northward of Cape Hatteras, considered as a *north-east storm.*—(*See Chart, Route VII.*)

It appears that this commenced at the Island of St. Thomas, in the West Indies, on the night between the 12th and 13th of August. On its progress, in the afternoon of the 14th, it commenced at the Bahama Islands, and continued during the succeeding night, the wind almost round the compass during the existence of the storm. On the 15th, in the Florida Channel, its effects were very disastrous. Without the strait, in lat. 26° 51′, long. 79° 40′, the gale was severe from N.N.E. to S.W. Late on the same day, off St. Augustin, it was equally so. At 20 miles North of St. Mary's, from 8 p.m. on the 15th, to 2 a.m. on the 16th, it was from an eastern quarter, then changed to S.W.

Off Tybee and at Savanna, on the night of the 15th, it changed to N.W. at nine a.m., on the 16th, and blew till twelve, On the 18th, at Charleston, the gale was from S.E. and East, till four p.m.; then N.E. and round to N.W. At Wilmington (N. Carol.) the storm was from the East, and veered subsequently to the West. In the vicinity of Cape Hatteras, at sea, the storm was very heavy from S.E., and shifted to N.W.

Early in the morning of the 17th, the gale was felt severely in the Chesapeake, from the N.E. Off the Capes of Virginia, on the 17th, lat. 36° 20′, long. 74° 2′, "a perfect hurricane," from South to S.S.E., from five a.m. to two p.m., then shifted to N.W.

Off Cape May, lat. 32°, long. 74° 15′, in the afternoon of the 17th, a heavy gale from E.N.E. Coast of New Jersey, same afternoon, heavy at N.E. Again, in lat. 39°, long. 73°, at E.N.E. In the same latitude, long. 70° 30′, a "tremendous gale," commencing at S.S.E., and veering to North.

Afternoon and evening of the 17th, at New York and in Long Island Sound, gale at N.N.E. and N.E. Off Nantucket Shoals, at eight p.m., severe at N.E. by E. In the night of the 17th, off Nantucket, and in the Gulf Stream, lat. 38° 15′, long. 67° 30′, "tremendous," commencing at South, and veering, with increasing severity, to S.W., West, and N.W. Peninsula of Cape Cod, in the night between the 17th and 18th, severe at N.E.; 18th, at Salem and Newbury, heavy gale from N.E. In lat. 39° 51′, long. 69°, severe from S.E., suddenly shifting to North. In lat. 41° 20′, long. 60° 25′, "tremendous hurricane" from N.N.E.

Off Sable Island, in the night of the 18th, lat. 43°, long. 59½°, "tremendous heavy gale," from South and S.W. to West and N.W. In lat. 43°, long. 48°, a severe gale from the South; the manner of change not reported.

This remarkable storm appears to have passed over the whole route above described in about six days, at an average of about 16 miles an hour; the duration of

its most violent portion, at the several points over which it passed, may be stated at from seven to 12 hours; and the width of its track is supposed to have been from 150 to 200 miles.

"On the western part of the Atlantic Ocean, between the parallel of New York and the northern limit of the trade wind, the prevailing winds, for a considerable period, both previously and subsequently to the occurrence of this storm, were south-westerly, or from the southern quarter; and over the whole breadth of the Atlantic, on the route frequented by ships in the European trade, fresh south-western or westerly winds also prevailed at the same period, for many weeks. These facts are well established by numerous marine journals, which have been consulted in relation to this subject.

Of the vorticular or rotative character of the storm, striking evidence has been afforded by the journals of two ships, the *Britannia* and the *Illinois*, both bound from America to Europe; the particulars of which are fully given in the Exposition by Mr. Redfield.

(131.) *In about a week after the storm last described*, another occurred, which passed New York on the 26th and 27th of August, and which was, also, on this coast, a N.E. storm, of about three days duration. From the eastward of the Bahamas it appears to have passed northwardly between the Florida Stream and the Bermudas; and touching the American shore near Cape Hatteras, raged with great fury for about forty hours at each locality, as it swept the great central curve of the coast; and passing from thence, continued its course over George's Bank, in a north-easterly direction. It was evidently of greater compass, and slower progress, than the preceding storm, as is proved by a collation of the various reports of mariners; and its long duration, and its effects were almost equally violent.

The next remarkable series of hurricanes appear to have originated in the vicinity of the Windward Islands, near the close of September, 1830, and which, passing westward of the Bermudas, on a course nearly North, assumed thence a more easterly course, toward the southern edge of the Grand Bank of Newfoundland.—(*See the Chart, Route VII.*)

This storm was very disastrous. In lat. 20½°, long. 63°, it commenced, on September 22nd, at one p.m., and continued till half-past six p.m., from N.E. and S.W. alternately. On the same day it passed through lat 22° 46′, long. 65°. At night, on the 30th, in lat. 26° 7′, long. 66½°, "very heavy," for five hours and a half. On the 1st of October it arrived at lat. 30° 38′, long. 63°; severe at S.E., shifted to N.W.; thence it was found in lat. 33°, long. 66½°; lat. 34° 9′, long. 66° 12′; lat. 35°, long. 68°; lat. 38°, long. 63°; lat. 38½°, long. 57°; lat. 40°, long. 61°; lat. 40° 25′, long. 58° 24′; lat. 41°, long. 55°, and very severe. By an average estimate of rates and distances, it appears to have proceeded at the rate of about 27 miles an hour.

The extensive hurricane of 1804, which swept over most of the Windward Islands in the West Indies, commenced at Martinique, on the 3rd of September, reached Savanna on the 7th, Boston on the 9th, and became a *snow-storm* on its arrival in the interior of New Hampshire.

The great gale of 1815 commenced at St. Bartholomew's on the 11th of September, and reached Rhode Island on the morning of the 23rd, where it was awfully destructive from the S.E., while in the south-eastern parts of Massachusets, it was then blowing at South; at New London from E. to S.E.; and at New York from North to N.N.W.

(132.) *A S.E. storm in September*, 1821—*see Chart, Tract VIII.*)—was expeperienced in the central parts of Connecticut, commenced blowing violently from E.S.E. and S.E., at about six p.m. on the 3rd of September, having been preceded by a fresh wind from the southern quarter, and flying clouds. It continued blowing in heavy gusts, and with increasing fury, till about 10 p.m., when the wind suddenly subsided. A calm or *lull*, of perhaps fifteen minutes' duration, ensued, but was ter-

minated by a violent gust from the N.W., which continued till about eleven p.m., and then gradually abated. Much damage was sustained, and fruit-trees, corn, &c., were uniformly prostrated toward the N.W.

At New York the same storm was experienced, with at least equal violence, about three hours earlier than in Connecticut, but blowing from a more eastern quarter. In the north-eastern parts of Massachusets it was experienced some hours later; and at Providence, in Rhode Island, the storm was felt in the south-eastern quarter, but not severely; as was also the case in the south-eastern parts of Connecticut. In the N.W. portions of the latter state, and the adjacent towns of Massachusetts, the gale blew with its chief violence from the N.W. quarter, and the trees and corn were uniformly prostrated toward the S.E.

At New York the gale was from N.E. to East, and commenced blowing with violence at five p.m., continued with great fury for three hours, and then changed to W. More damage was sustained in two hours than was ever before witnessed in the city, the wind increasing during the afternoon, and *at sunset was a hurricane*. At the time of *low water* the wharfs were overflowed, the water having risen 13 feet in an hour. Previous to setting in of the gale, the wind was from S. to S.E., but changed to the N.E. at the commencement of the storm, and blew with great fury till evening, and then shifted to the westward.

(133.) *The Cyclone of August* 1870* took the following course. The calm centre passed Antigua on August 21 at $6^h\ 40^m$ a.m.; St. Kitts, at 9^h a.m.; St. Eustatius, at noon; St. Thomas, at $5^h\ 15^m$ p.m.; Turk's Island, August 22, at midnight; Long Island, August 23, at $5^h\ 30^m$ p.m.; Great Exuma, at $8^h\ 30^m$ p.m.; Nassau, August 24, at $4^h\ 30^m$ p.m.; Key West, about 8 p.m.; Panta Rassa, 5^h p.m.; Lake City, 6^h p.m.

The rate of progress of this cyclone in passing Antigua was 18 miles per hour. At St. Thomas it slackened to $13\frac{1}{2}$ miles per hour. In Florida it was only $8\frac{1}{4}$ miles per hour, and farther North only 5 miles per hour. This diminution in the progressive movement may probably be accounted for by the obstruction to the cyclone created by the hills in several of the islands over or round which it had to pass.

With regard to the diameter of the cyclone, Mr. Jahncke, of St. Thomas, who seems to have studied the whole phenomena most scientifically, estimated what he calls the "inner or furious part," at about 180 or 200 miles; the entire diameter was about 300 miles. Others, however, judging from the track marked on some of the islands by the damage done, estimated the diameter at only 50 or 60 miles. As to the central part, where a comparative calm existed that of course was formed by the meeting of opposite winds, just as near the equator a calm region prevails from the same cause. The diameter of this central cyclonic calm may be estimated; for if it lasted half an hour at any place passed by the cyclone, and the cyclone itself was moving forward at the rate of 18 miles an hour, the calm centre must have been about 9 miles in diameter.

The following shows the barometric depression and direction of wind at St. Thomas:—August 21, noon, 29.83, wind N.E.; 1 p.m., 29.57, N.N.E.; 2 p.m., 29.19, N.N.E.; 3 p.m., 29.17, North; 4 p.m., 28.85, N.N.W.; 5 p.m., 26.68, West; $5^h\ 35^m$ p.m., calm; 6 p.m., wind S.W.; 7 p.m., wind S.S.W. The barometer rose gradually after the calm.

This cyclone is stated to have been *divided into two portions* in passing the high ground (6,000 feet) of Puerto Rico. One part of the cyclone diverged to the N.N.W., and the other and larger portion proceeded onward W.N.W. The first part of the cyclone, Mr. Jahncke states, went towards Bermuda, and was encountered by the brig *Ada*, in lat. 26°, long. 69°.

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* Notes on West India Cyclones, by D. Milne Holme, L.L.D. "Journal of the Scottish Meteorological Society," January and April, 1873. See also page 261.

ON MAKING USE OF HURRICANES.

(134.) It has been proposed by Mr. Piddington to make use of these storms, by taking advantage of the favourable wind which some portions of their circumference offer for expediting the voyage. This has also been proposed by Sir W. Reid, in his "Law of Storms." Mr. Piddington has given rules for this, in the regions he has made more particularly his study —the Indian and China Seas; but here the hurricanes do not appear to travel at so great a speed as those of the Atlantic.

In order to benefit by the hurricane, several conditions are necessary; and it need not be again insisted on, that any error or ignorance of the centre of rotation may be fatal. Of course, the first consideration is, in what part of the circumference is the ship, and in what bearing is its centre?—then, at what rate, and in what direction, is it travelling?—and is it so violent that the ship cannot weather it? All these things must be weighed well by the mariner, before he endeavours to lay his ship on that tack which will appear the best to forward his voyage. Should the storm be advancing in the same direction as his course, and the position of the ship be upon the anterior verge, should it travel at a rate above that which he can keep up with it, it is evident that it will pass over him, and the consequence need not be remarked upon. Should the vessel be upon the posterior verge of the hurricane, it will, if travelling at 20 or 30 miles an hour, soon leave her, and then no advantage can follow.

Thus, to "make use of a hurricane," several conditions are absolutely necessary: these are—"1. The ship must get into the storm precisely where the wind blows fair for prosecution of the voyage—which is quite a matter of chance. 2. If she happen to do so, she must, to derive benefit, regulate her speed exactly to that of the meteor. Can she do that at pleasure? There would be no difficulty in ascertaining the fact of her preserving her station, or not, by the wind remaining steady, or veering; but there is a necessity that would bind her, and which cannot be evaded with impunity when a high sea follows; she must carry a certain proportion of sail to prevent her from being pooped. Now this sail may give her a greater velocity than the meteor at the time; hence she would run ahead of it. Again, the rate of the meteor may be greater than her utmost speed; hence she would be ejected."

* Lieut. Macfarlane remarks that he has never seen a warning given to vessels, making use of the favourble wind on the eastern side of a cyclone, to avoid the storm at its point of recurving from N.W. to N.E. A vessel steering to the northward, having the wind aft, may possibly keep up with the progress of the hurricane; but on its reaching its point of recurving would be in danger of having the vortex pass over her. He is referring to the cyclone, Track No. XII. on the diagram, which is laid down from the remarks of six ships.

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* From remarks on the Hurricane of August 1873, by Captain H. Toynbee, F.R.G.S., &c. See "Quarterly Journal of the Meteorological Society," No. 9, January 1874.

WHITE SQUALLS OF THE WEST INDIES.

(135.) Mr. F. A. Jahncke,* of St. Thomas, says on this subject:—I think it would not be out of place to say a few words on White Squalls which happen sometimes, and are terribly destructive to vessels, either capsizing them or carrying away their masts. They occur with fine weather and a good breeze, but I have not heard that they happen on land, but always at sea. It must be a rapid descent of the equatorial wind met below by the trade wind, which arrests its circular motion; that must be the cause, as their duration is only for a few moments.

Captain Toynbee remarks that he has been struck by the frequency of squalls from the direction of the upper current of air in parts of the sea where the lower wind was from nearly an opposite direction. In studying square 3 he found that at the northern verge of the S.E. trade the upper clouds very frequently moved from N.E., and squalls would come from N.E., though the steady lower wind was always S.E. or southerly, as if the upper current of air sometimes forced its way downward through the lower current, causing the squall, and then rose again.

9.—WATERSPOUTS.

(136.) The well-known phenomenon, called a *Waterspout*, which is frequently seen on the Atlantic, proceeding from black dense clouds, always appears in warm weather, generally in calms, or with little wind; but they have been seen during a fresh gale. It has been shown, by the celebrated Dr. Franklin, and other writers, that a whirlwind on land, and a waterspout at sea, arise from the same general causes, and may be considered as one and the same. At sea they are commonly harmless, unless ships happen to be immediately under them; but if, in the progressive motion of the whirl, it passes from the sea over the land, and there suddenly breaks, violent and mischievous torrents are the consequence. At sea, after the spout breaks, the water descends in the form of very heavy rain. In the vicinity of a spout, the wind commonly flies round in sudden gusts, and all ships should therefore take in their square sails.

That a waterspout and whirlwind are identical, has been amply demonstrated by those who have seen this meteor pass from the sea to land, and the contrary. They have both a progressive as well as circular motion; they usually appear after calms and great heats, and mostly happen in the warmer latitudes.

(137.) Marine waterspouts, therefore, are caused by the action of atmospheric currents. Malté-Brun thus describes them:—"Underneath a dense cloud, the sea became agitated by violent commotions, the waves dart

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* General remarks on West India Cyclones, by F. A. Jahncke, see "Quarterly Journal of the Meteorological Society," No. 10, April 1874.

rapidly toward the centre of the agitated mass of water, on arriving at which they are dispersed into aqueous vapours, and rise whirling round, in a spiral direction, toward the cloud. This conical ascending column is met by another descending column, which leans toward the water, and joins with it. In many cases the marine column is from 50 to 80 fathoms in diameter near its base. Both columns, however, diminish toward the middle, where they unite; so that here they do not extend more than 3 to 4 feet in diameter. The entire column presents itself in the shape of a hollow cylinder, or tube of glass, empty within. It glides over the sea without any wind being felt; indeed, several have been seen at once following different directions. When the cloud and the marine base of the waterspout move with unequal velocities, the lower cone is often seen to incline sideways, or even to bend, and finally to burst in pieces. A noise is then heard, like the noise of a cataract falling in a deep valley; lightning frequently issues from the very bosom of the waterspout, particularly when it breaks, but no thunder is ever heard."

In order to prevent the danger which a vessel would be exposed to by coming in contact with these tremendous columns, it is the practice to discharge upon them a cannon ball, which, passing through them, causes them to burst, and consequently removes all chances of injury connected with them. This phenomenon is accounted for in the following manner:—Two winds meet—a vortex ensues; any cloud which happens to be between them is condensed into a conical form, and turned round with great velocity; this whirling motion drives from the centre of the cloud all the particles contained in it; a vacuum is thereby produced, and water, or any other body lying beneath this vacuum, is carried into it upon the usual and well-known principle. The cannon-ball, breaking this cylinder, which is always partly hollow, causes it to fall to pieces, in the same manner as a touch upon the surface of a bubble reduces the resplendent mass to a drop of common water.

(138.) The following description of a Waterspout, seen during a fresh gale upon the coast of North America, was written by Mr. Murdo Downie.

"Upon the forenoon of the 9th of October, 1795, while cruising in his Majesty's ship *Resolution*, (then bearing the flag of the late Admiral Murray), in company with H.M.S. *Africa*, commanded by the late Admiral, then Captain, Home, in lat. 32°, and long. 66½° W., having the wind at N.N.W. blowing a fresh gale, and the ship steering by the wind East for the Islands of Bermudas, we were surprised by a waterspout, formed in an instant, directly to leeward, at about 2 miles, or little more, distant. Both the *Africa* and we fired several 18-pound shot at it, which fell a little short; and, although some of the shot fell very near, yet they had no visible effect upon it. Its appearance was that of a long slender pillar, with the upper end spreading into a large dense cloud, of which it seemed to form a part, and the lower end reached to within about 20 or 30 feet of the sea, where it was obscured from the sight by waters being violently thrown up and agitated, so as to resemble a number of fountains or water-engines playing perpendicularly round the lower end of the spout. The pillar became more transparent in proportion as it decreased in size from the cloud downward, until at the lower end, where it was almost perfectly so; and a small

column, of an equal diameter, and more transparent than the rest, appeared up through the middle, so that about the lower end it resembled an empty glass tube in appearance; from thence the transparent column in the middle became gradually obscured, the higher up, by the opacity of the outside, until it altogether disappeared near the cloud. The spout appeared at its full size, or nearly so, when first seen, and began to decrease shortly after, and turning gradually smaller, in a short time vanished in a slight shower.

"We were too intently gazing at this extraordinary phenomenon to mark the exact time it lasted, but supposed it to continue ten or fifteen minutes; and its distance from the ship was pretty accurately ascertained by the shot fired at it nearly reaching; but what appeared most remarkable was, that, although the wind blew so strong a gale, that the ship could carry only reefed topsails from which the velocity of the wind cannot be estimated at less than 30 or 40 miles an hour), yet the waterspout seemed to move but very little from the place where it was first seen. The ship was going at the rate of 5½ miles an hour, and increasing her distance from the spout; yet, after continuing the above-mentioned time, it was considerably within the verge of the visible horizon, as seen from the quarter-deck, when it vanished (as upon the quarter-deck the eye was elevated 23 feet above the surface of the sea, the horizon would therefore be seen about 6 miles distant). Now, allowing the ship to have increased her distance from the spot half a mile during its continuance, and that it vanished a mile within the verge of the visible horizon), leaves 2½ miles for the spout to move in ten minutes; whereas the wind must have gone at least 5 miles in that time, and consequently 2½ miles faster than the waterspout. Indeed, it is very probable the waterspout did not move so much, in proportion to the wind, as the above calculation gives the least difference between their motions that could have been allowed from the observations; the intention of this calculation being principally to prove that the waterspout in some measure resisted the force of the wind.

"I have always observed that waterspouts, lightning, and other electrical phenomena, are far less frequent toward the middle of the ocean than they are upon the land, or near it, and when they happen upon the sea, the cloud that contains them is generally observed to have come from off the land; from which reason we find that electrical phenomena are more frequent, and are found to reach to a greater distance, upon the sea bordering the East coast of North America, than upon that bordering the West coast of Europe; because of the prevailing westerly winds carrying the clouds charged with electric fluid off the land upon the sea near the American coast; whereas upon the European coast these winds confine the clouds upon the land. It is also a known fact, that within the limits of the N.E. Trade-winds, and half-way between the Cape Verde and Windward West India Islands, more especially in the latitude of these islands, scarcely any of these electrical appearances ever happen; whereas upon the shores of Africa and America, in the same climate, they frequently rage with great fury.

(139.) *Description of Waterspouts by Mr. George Maxwell.*—There can be no doubt that waterspouts have, in most cases, been accompanied with electrical phenomena; and it is equally certain that the spiral and ascending motion of the water has been produced by a gyratory movement in the air, arising

from the meeting of two opposite winds. Mr. Maxwell had opportunities, during several voyages to the Congo, of frequently witnessing this interesting phenomenon; and in a drawing, from which the subjoined figure has been made, he has represented the different states of a waterspout, as they commonly occur.

At their first formation, Mr. Maxwell says, they appear as at A, where the black cloud drops from a level surface into a conical form, before the disturbance at the surface of the sea, as shown at D, is observed. The effect produced at D is like that of a smoking furnace. The black conical cloud now continues to descend, as shown at B, till it almost reaches the surface of the sea, and the smoke-like appearance rises higher and higher, till it forms an union with the cloud from which the spout appears to be suspended. In this condition it is said to put on its most terrific appearance to vessels which have the misfortune to be in its neighbourhood. When the spout begins to disperse, it assumes the appearance shown at C. The black cloud generally draws itself up in a ragged form, but leaves a thin transparent tube, CE, which reaches the water, where the smoke-like commotion still prevails. Mr. Maxwell observed, at this time, in the upper part of the tube, a very curious motion.

This singular fact, of the existence of a transparent tube, confirms a description, by M. Alexander Stewart, of waterspouts which he saw in the Mediterranean, in 1701. "It was observable of all of them, but chiefly of the large pillar, that toward the end it *began to appear* like a hollow canal, only black in the borders, but white in the middle; and though at first it was altogether black and opaque, yet one could very *distinctly perceive the sea-water to fly up along the middle of this canal as smoke does up a chimney*, and that with great swiftness, and a very perceptible motion; and then, soon

after, the spout or canal burst in the middle, and disappeared by little and little; the boiling up and the pillar-like form of the sea water continuing always the last, even for some considerable time after the spout disappeared, and perhaps till the spout appeared again, or re-formed itself, which it commonly did in the same place as before, breaking and forming itself again several times in a quarter or half an hour."—"Phil. Transactions, 1702."

Admiral William H. Smith, in his interesting volume on Sicily and the Sicilian Islands, has noticed, that "waterspouts and various singular meteoric phenomena occur in that neighbourhood. Among the latter, on a warm, cloudy, and hazy day, the 19th of March, 1814, it began to rain in large drops, that appeared muddy, and they deposited a very minute sand of a yellowish red colour. The wind, on the day before, had been blowing strongly from the S.S.W. to the N.E.; and, during the time the rain fell, was from the S.W., which leads to the supposition that it was transported from the deserts of Africa." This remark accords with a number of others on the sand from the *Sahara* or *Desert*, which is carried by the wind over the Atlantic, to an almost incredible distance from the western coast.*

(140.) To the preceding descriptions we annex another, as given by the Honourable Captain Napier, R.N., F.R.S.E., in 1814.

"On the 6th of September, 1814, in lat. 30° 47′ N., and long. 62° 40′ W.,† at half-past one p.m., the wind being variable between W.N.W. and N.N.E., the ship steering S.E., an extraordinary sort of whirlwind was observed to form about 3 cables' lengths from the starboard bow of H.M.S. *Erne*. It carried the water up along with it in a cylindrical form, in diameter, to appearance, like that of a water-butt, gradually rising in height, increasing in bulk, advancing in a southerly direction, and, when at the distance of a mile from the ship, it continued stationary for several minutes, boiling and foaming at the base, discharging an immense column of water, with a rushing or hissing noise, into the overhanging clouds; turning itself with a quick spiral motion, constantly bending and straightening, according as it was affected by the variable winds, which now prevailed from all points of the compass. It next returned to the northward, in direct opposition to the then prevailing wind, and right upon the ship's starboard beam, whose course was altered to East, in hopes of letting it pass astern. Its approach, however, was so rapid, that we were obliged to resort to the usual expedient of a broadside, for the purpose of averting any danger that might be apprehended; when, after firing several shots, and one, in particular, having passed right through it, at the distance of one-third from its base, it appeared for a minute as if cut horizontally in two parts, the divisions waving to and fro in different directions, as agitated by opposite winds, till they again joined for a time, and at last dissipated in an immense dark cloud or shower of rain."

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* Colonel Reid has given, in his "Law of Storms," a chapter (xi.) on "Waterspouts and the smaller Whirlwinds," with several beautiful figures of the same, which have been repeated in the Nautical Magazine," of July, 1830.

† About 45 leagues S.E. from the Bermudas.

"The near edge showered in large heavy drops on the ship's deck, until the cloud was quite exhausted.

"At the time of its being separated by the effect of the shot, or more probably by the agitation occasioned in the air by the discharge of several guns, its base was considerably within half a mile of the ship, covering a portion of the surface of the water at least half a furlong, or 300 ft. in diameter, from one extreme circumference of ebullition to the other; and the neck of the cloud into which it discharged itself appeared to have an altitude of 40° of the quadrant, while the cloud itself extended overhead, and all around, to a very considerable distance.

"Allowing, then, from the ship, a base of little more than a third of a nautic mile, say 2,050 ft., and an angle of 40° to the top of the neck, we shall then have, for the perpendicular height of the spout, about 1,720 ft., or very nearly one-third of a statute mile. A little before it burst, two other waterspouts, of an inferior size, were observed to the southward, but their continuance was of short duration.

"When danger was no longer to be apprehended, I observed the barometer, and found it at 30.1 inches, with the surface of the mercury very convex; an appearance which it had not assumed when at the same height at noon, about two hours before; the thermometer stood at 82°, having risen 1° since that time.

"During the continuance of the waterspout, and the subsequent rain, which might be a little more than half an hour, the wind blew from all points of the compass at different times, generally shifting at opposite points, never longer than a fresh breeze for a moment, but in most instances quite light. It was unattended with any thunder or lightning, and the water that fell from the cloud was perfectly fresh.

"Having witnessed this extraordinary phenomenon, I endeavoured to ascertain its cause.

"Although this phenomenon was rather terrific in appearance, yet I am not inclined to think it would have been attended with any serious calamity to the ship, had even the whole quantity fallen on board, allowing the loftier sails to have been taken in, the hatches battened down, and scuppers open. The cylinder or spout coming in contact with the masts and rigging, would naturally be destroyed; and the air rushing in, instantaneously, to restore the equilibrium, the torrent would thus be checked in its fall by the mere weight or force of a tropical descent. I have heard many reports of ravages committed by these aqueous meteors, but never yet met a person who had actually witnessed or experienced any such distressing effects."

10.—OF THE TIDES.

(141.) As introductory to a General Table of the Tides, we shall give a few passages from *M. Malté-Brun*, explanatory of the subject; and also the results of the recent extensive observations and profound researches of *Professor Whewell* and the late *Sir John Lubbock*.

The water of the sea yields to the slightest impression; and, although its density and weight combine to retain it in a constant equilibrium, it is agitated to a certain depth by rapid and varied motions. These motions may be classed according to the manner in which the particles move, and according to the nature of the agents which cause the motion.

Three kinds of motion may be distinguished in the sea, considered in reference to their causes. The TIDES are *sidereal motions*, because they depend upon the influence of the heavenly bodies. *General Currents*, and the greatest number of *Particular Currents*, have their causes in the very element that is agitated by them; these, then, are *motions of the sea itself.* The third kind comprehends *atmospheric motions*, produced by the action of the winds.

The TIDES are regular and periodical oscillations, which the seas undergo from the attraction of the celestial bodies, principally those of the moon and sun.

(142.) *Action of the Moon.*—Let us first consider the single action of the moon upon the sea; supposing that luminary to be in the plane of the Equator. It is evident that, if the moon exerted upon all the particles of the sea an equal attraction, and parallel to the earth's centre of gravity, the entire system of the globe, and of the waters which cover it, would be influenced by a common motion, and their relative equilibrium would not suffer any change. The equilibrium is disturbed only by the difference between the attractions which the moon exerts, and the inequality of their directions. Some parts of the globe are *directly* attracted by the moon; others only obliquely. The former are in conjunction with the moon; and a line drawn from the centre of the two planets would pass through their zenith. The latter are in quadrature with the moon—that is to say, a line drawn from the terrestrial centre to their zenith would make an angle of 90° with the line which connects the centres of the two planets. The attracting force acting obliquely is decomposed by the obliquity of its angle of incidence; thus the parts in conjunction being more strongly attracted than those in quadrature, the weight of their particles is diminished. It is necessary, then, to there being an equilibrium in all parts of the sea, that the waters should rise under the moon, in order that the excess of weight of the particles in quadrature, above those in conjunction, may be compensated by the greater height of the latter.

The waters, however, rise, not only on the side where the attracting planet is, but, also, on the opposite side; because, if the planet attract the superior waters more than it attracts the centre of the earth, it also attracts this centre more than it attracts the inferior waters in the opposite hemisphere. These waters will then approach less toward the attracting planet, than the centre of the earth approaches to it. They will remain as far off, from and behind the centre, as the superior waters advance from it on the side of the moon.

Two promontories, or eminences of water, will therefore be formed by the action of the moon upon the earth; one on the side toward the moon; the other on the side opposite to it; which gives the sea an appearance of an elongated spheroid, whose great axis will pass through the centre of the moon and of the earth. It is *high tide* under the moon and in the opposite

point at 180 degrees of distance; consequently, in the two intermediate points, or at 90 degrees of distance from the moon, the tide will be *low*.

The earth, by its rotatory motion, successively presents to the moon, in the space of twenty-four hours, all its meridians, which, consequently, are found by turns, and at an interval of six hours, sometimes under the moon, and sometimes at a distance of 90 degrees from it; hence it follows that, during the time which passes between the departure of the moon from one meridian, and its return to the same meridian, that is, in the space of a lunar day, which exceeds the solar day by about fifty minutes and a half, the waters of the sea will ebb twice, and flow twice, in every part of the earth, although in a manner almost insensible in those places which are distant from the path or orbit of the moon.

(143.) *Action of the Sun.*—If we now imagine the sun to be in the plane of the Equator, it is evident that, as its action is similar to that of the moon, it should excite in the ocean an agitation similar to the lunar tides. Thus the sea would ebb twice and flow twice during a solar day; but, on account of the immense distance from the sun, those solar tides will be much smaller than those which result from the action of the moon.

On account of the inequality which exists between the solar and lunar days, the action of the sun will sometimes change the position of the lunar tides, and at other times will unite its influence with that of the moon. In the syzigies, or conjunctions, the action of the moon concurs with that of the sun to raise the waters. This is the reason why the highest tides happen at new and full moon; or when the moon is in its first or third quarters. In the quadratures, the waters of the sea are depressed by the action of the sun, at the same point where the action of the moon raises them, and reciprocally. Thus the tides of the quadratures ought to be less.

The height of the tidal wave produced by the moon is as that produced by the sun as 100 to 38, when combined, of course, they produce the spring tide, as above stated; opposed, they make neaps, the range of them being as 138 to 62, or nearly as 7 to 3. Newton (from the Severn tides) make it 4.48 to 1, which is far too large. Laplace (from the Brest observations), makes it 2.90 to 1, and the late Sir John Lubbock and Dr. Whewell about 2.66 to 1. Of course, these relations are very much controlled in action by the configuration of the coast or channel.

(144.) What we have already explained regards the position of the sun and moon in the Equator. Let us now consider these heavenly bodies in their various declinations, and we shall see the elevation vary in the inverse ratio of the cube of the distance of the water.

Without entering into details, which would require mathematical demonstrations, we shall remark only, that the proximity of the sun and moon seems to be the cause to which we must refer the extraordinary equinoctial tides, which happen most frequently; the one before the *vernal equinox*, and the other after the *autumnal;* that is, both of them at the time when the sun, passing through the meridional signs, is nearest us. But this does not happen every year, because there are sometimes variations produced by the situation of the orbit of the moon, and by the distance of the syzigies from the equinoxes.

(145.) This, then, is the general *theory* of the tides, and from these obser-

vations of their general laws may be inferred; but it has been reserved for later times to pursue the inquiry into detail, and to develop the minor effects which modify, and in some places totally change, the character of the tides. It is chiefly to the late *Rev. Dr. Whewell*, Master of Trinity College, Cambridge, and to *Sir John Lubbock*, that our present knowledge of the tide laws is owing, and from their observations we will give some extracts.

(146.) In the Rev. Dr. Whewell's papers on the subject of the Tides, he commences:—"Ever since the time of NEWTON, his explanation of the general phenomena of the tides, by means of the action of the moon and the sun, has been assented to by all philosophers who have given their attention to the subject. But, even up to the present day, this general explanation has not been pursued into its results in detail, so as to show its bearing on the special phenomena of particular places—to connect the actual tides of all the different parts of the world—and to account for their seeming anomalies. With regard to this alone, of all the consequences of the law of universal gravitation, the task of bringing the developed theory into comparison with multiplied and extensive observation is still incomplete; we might say, is still to be begun.*

(147.) *The Tidal Wave.*—The tidal wave is not owing to the transfer of the body of water, which would be a current, but to an *elevation* of its surface. This motion is, as readily conceived, compatible with immense velocity; and it may be taken as a rule, that the broader the wave, the greater will be its velocity. If the earth were in equilibrium, and its surface entirely covered with water, and under the influence of the moon's attraction, it would assume the form of an ellipsoid, having the semiaxis directed towards the moon longer by about 58 inches than that transverse to it; that is, the water would become higher by that amount. This is merely adduced to show what may be the amount of the luni-tidal wave, without entering into any other considerations.

(148.) *Velocity of the Tidal Wave.*—As the whole of the tidal wave must circulate around the globe in twenty-four hours nearly, the velocity must be very great; but it is greatly modified. In the middle of the Atlantic it would appear to travel at the rate of about 700 miles an hour, but on the coast it is widely different; hence its velocity along the eastern coast of England varies from 35 miles to 160 miles per hour.

In the open ocean, where nothing intervenes to obstruct the course of the tidal wave, it travels probably with regularity; and it may be presumed that its height is also inconsiderable. But when this wave, from an open ocean, approaches a narrow channel, such as the Bristol or English Channel—from being hemmed in, as it were, it forms a *tide current*. Now, along the centre of such a channel the tidal wave would travel with much greater speed than on the sides. Hence the distances at which the hour-marks representing high water will be wide apart in the centre, and transverse to its general direction; while on the shores, the direction of the wave would be altered,

* "Essay towards a First Approximation to a Map of Cotidal Lines;" Philosophical Transactions of the Royal Society, 1833, p. 147.

and it will approach parallel to the shore; hence the hour-marks will be close together, and parallel to the general direction of the main tide-current.

The tide-wave, advancing through the contracting channel, towards the end becomes of great height, and, as at Bristol, and in the Bay of Fundy, sometimes rises to the enormous height of 50 or 70 ft.; just in the same manner that the surf runs up a shelving beach.

The variation in the height of the tide (as is found to be the case in some parts of the coast of France, between places near each other, and having high water at the same time, is to be accounted for by the convex form of the tidal wave.

In some parts of the world, as in Australia, Kamtschatka, &c., the tides offer very singular anomalies. At Adelaide, in South Australia, it is high water only once in the twenty-four hours, and that during the night. This arises from what are called *interferences*, whereby two distinct sets of tidal waves, in their combination produce apparent rest.*

(149.) One of the most important circumstances of this subject is, that, in an open channel, the *flood current* (the current which runs till high water) will continue running for three hours afterwards, or till *half-ebb*; and the ebb current, which then begins, will run after low water till half flood. The time of slack water is intermediate between the times of high water and low water. In proportion as the channel is obstructed at the further end, the flood current runs for a shorter time after flood; and in a closed creek, the flood current ends at high water.†

Another error to correct is this:—"That the time of the change of current, or the *time of slack water*, as it may be termed, *never* coincides with *the time of high water*, except close in-shore, and within its influence; the interval is generally considerable. Great confusion has arisen from these two times not being properly distinguished."—"Phil. Trans.," 1833, p. 162.

(150.) *The Establishment of the Port.*—The vulgar establishment of the port is the interval of time by which the time of high water follows the moon's transit *on the day of the new and full moon*. This is, corrected, the *mean* value of the interval, freed from the semi-menstrual inequality. Its value at the London Docks is one hour twenty-six minutes, by the mean of all the observations.—"Phil. Trans.," 1834, p. 19.

The Corrected Establishment.—The mean luni-tidal interval, or *corrected establishment* of each place differs from the vulgar establishment, or time of high water for new and full moon; for the time of high water at syzigy is affected by the semi-menstrual inequality belonging to the moon's position one or two days earlier, and is therefore later by about thirty minutes than the mean interval would give it.‡

(151.) *The Semi-monthly Inequality.*—The interval of tide and month's transit is affected by a considerable inequality, which goes through its period *twice* in the space of one month; it may be considered as depending upon the moon's distance from the sun in right ascension, or, which is the

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* Phil. Trans., 1833, p. 154. † Phil. Trans., 1833, p. 215.
‡ Phil. Trans. (Whewell), 1836), p. 292.

same thing, on the solar time of the moon's transit. The difference of the greatest and least intervals at London is one hour twenty-eight minutes.*

(152.) *The Age of the Tide.*—The tide does not depend upon the passage of the moon upon that particular day or hour, but from some previous transit; hence the tide is observed to take place at London at two o'clock on the days of new and full moon; therefore, as the tide of London is found to be determined by the position of the sun and moon upon two days and a half before it occurs, one hour twenty-six minutes is the *corrected establishment* for London, as stated above.†

(153.) *Difference of the Two Diurnal Tides.*—It has been remarked in various places by separate observers, that the evening tide is higher than the morning tide in one part of the year, and lower at another. This is thus explained by Newton. From the vernal to the autumnal equinox, the sun has North declination; and as the moon's orbit is never much inclined to the sun's, a line drawn from the earth's centre to the moon would meet the earth's surface, on the side towards the sun, in North latitude. Now, such a line is the axis of the tide-spheroid, supposing the tide to be always under the moon; and the tide taking place when the moon in the meridian is higher, as the place is nearer to the vertices or points where the axis of the tide spheroid meets the earth's surface. Hence, in this case, the tides which occur on the side of the earth next the sun, or the day tides, would be larger for a place in North latitude than the tides on the opposite side. For a similar reason, the night tides would be higher in winter.

(154.) *Height of Mean Water.*—The mean between high and low water is found to be constant and permanent, however much may be the difference of high and low water. It has been found, from a great number of observations on the South coast of England, not to vary more than 2 or 3 inches; therefore all heights ought to be referred to the *mean* level of the sea, instead of the vague and uncertain data of high or low water.

The refined surveying operations which have of late been completed have demonstrated one singular fact, which could only have been elicited in the laborious and exact processes carried on during the Ordnance Survey. It is, that the *mean level* of the sea, as we assume it, is *not a level*, from whatever cause it may arise, and it is difficult to assign one. It is found that the *mean* level of the sea around Ireland is lower on the South than it is on the North coast. Taking Courtown in Wicklow as the standard—a spot remarkable as the node or axis of the great tidal wave of the St. George's Channel, and where there is little or no rise or fall; at Ballycastle on the North, the mean sea level is higher by 0·881 foot, and lower on the South at Castle Townsend by 0·938 foot than it is at Courtown. Thus the mean level is nearly 1 foot 10 inches higher on the North than it is on the South of Ireland. Of course this fact has no bearing upon the seaman's application of tidal phenomena, but is curious.

(155.) It has been found that a low barometer causes a higher tide and the reverse. This element, in the disturbance of the regular tides, the effects of atmospheric pressure, has been estimated by different observers, and its amount has been ascertained with considerable accuracy. Thus, at

* Phil. Trans., 1834 p. 19. † Phil. Trans., 1839, p. 154.

Liverpool, there is a difference in the *height* of high water of 10·1 inches for a variation of 0·91 in the barometer; and at London it has been calculated by Mr. Dessiou that the water rises 6·3 inches for ·90 depression of the barometer. M. Daussy has ascertained that, at Brest, the ocean rises ·223 metre, or 8·78 inches, for a depression of 0·158 metre, or ·622 inch in the barometer.* These results are nearly identical with those ascertained by Sir James Ross in the Arctic regions in 1848 by means of the steady level of the winter ice. These refinements in tidal calculations are, perhaps, of little value for the practical mariner when at sea; they may be useful in entering a dock; but they are of the utmost service in generalising the phenomena of the tides, upon which so little, it may be said, is known that may be applied.

(156.) The foregoing are the principal effects of the causes which produce the tides in reference to their rise and fall. There is another branch of the subject, however, which is of great importance to the navigator; that is, the currents formed by the alternate elevation and depression of the ocean. As before mentioned, in the open sea it may be considered that there is no tidal current, and that the tidal wave is propagated without any actual displacement in the particles of the water. But when this wave approaches the coast, the case is widely different, and the wave must necessarily form a current, sometimes flowing in one direction, and at others in the opposite one. This variation in the progress of the flood and ebb tide wave must vary with every locality, and is influenced by the particular configuration of the coasts, &c., by which it passes. The question of the form and transmission of waves is so complicated, and involving mathematical analysis of so high an order, that it cannot be usefully dwelt on here.

Upon the direction in which the great tidal wave is propogated, we at present have much to learn. It has been supposed by the late Sir J. Lubbock, that it travels from the Cape of Good Hope to Gibraltar in twelve hours; from Gibraltar to Edinburgh in about twelve hours; and from Edinburgh to London in about twelve hours,† which is in accordance with Bernouilli's theory. Passing north-eastward from the South Atlantic, it strikes the S.W. shores of Great Britain and Ireland, and becomes divided by these lands; one portion of the great wave passes northward to the West of Ireland, a portion of it enters by the North Channel, and meets a large portion from the South which has passed up the St. George's Channel, another passes up the English Channel passing on to the North Sea along the Dutch and German coasts, and with another portion of the western branch which enters the North Sea between Norway and Scotland, causes a circulation of tides which is still involved in some obscurity, but which is elucidated elsewhere; the remainder passes north-eastward along the Norway coast on to the Polar basin. Along the American coast the great wave passes from South to North, making high water at a later hour continually, and entering the various bays and outlets in the same manner. It may at once be mentioned that in low latitudes the rise and fall of the tide is very inconsiderable, and therefore comparatively unimportant.

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* Phil. Trans., 1836, pp. 220, 221; and Conn. des. Temps. 1834.
† Phil. Trans., 1836, p. 218.

(157.) In 1834, from the recommendation of the Rev. Professor Whewell, a series of tide observations were made, during a fortnight in the month of June, at the coast-guard stations in Great Britain and Ireland; and in the following year a much more extensive series was taken simultaneously between the 8th and 28th of June. "The chain of places of observation extended from the mouth of the Mississippi round the Cays of Florida, along the coast of North America, as far as Nova Scotia; and from the Straits of Gibraltar along the shores of Europe, to the North of Cape Norway. The number of places of observation was twenty-eight in America, seven in Spain, seven in Portugal, sixteen in France, five in Belgium, eighteen in the Netherlands, twenty-four in Denmark, and twenty-four in Norway; and observations were made by the coast-guard of this country at 318 places in England and Scotland, and at 219 places in Ireland." This large number of observations was also undertaken at the instigation of Professor Whewell, and their reduction was made by Mr. Dessiou and assistants, under his directions. The details and results are given in the "Philosophical Transactions," 1836, p. 289, *et seq.*

These observations have given us a far greater insight into the nature of the tidal progress than was had heretofore. A still more refined series was carried on for the English Channel by Admiral Beechey, as hereafter shown.

(158.) In the ensuing Tide Table for the North Atlantic the *vulgar* establishment (143) is given as the tidal hour at full and change, except in some cases, which are noticed as being the *corrected* establishment of the port. These figures are taken chiefly from the Government Nautical Surveys and the special observations which have been made in various places.

The height of the tide is here quoted as the *range*—that is, the difference of level between high and low water both at springs and neaps; so that the figures giving neaps do not represent the amount above the low-water spring tides, but the higher level generally of one-fourth of the difference of range.

Attached to the table are some brief remarks on peculiarities of the tidal phenomena, in the form of notes.

TIDE TABLE.

The Figures in Brackets (1.) *refer to the subjoined Notes.*

Place.	High Water, Full and Change.	Range. Sps.	Range. Nps.
England—Thames and South Coast.	h. m.	ft.	ft.
London Bridge (1)	2 7	19¼	14¼
London Docks	1 57	19½	
Gravesend	1 10	17½	
Nore	12 30	15½	11½
Margate	11 40	15½	10½
Ramsgate	11 44	15	9
Deal	11 15	16	
Dover (2)	11 12	18¾	11
Folkestone	11 7	20	13
Dungeness	10 45	21¾	17
Rye Bay	11 20	22	12½
Hastings	10 53	24	13
Beachy Head	11 20	20	10
Newhaven	11 51	20	10
Shoreham	11 34	18	10
Littlehampton	11 36	16	7¼
Selsea Bill	11 45	16½	8½
Portsmouth Dock Yard	11 41	12½	6½
Southampton (3)	10 30 / 12 45	13	6½
West Cowes	10 45	12½	6½
Hurst, Camber	10 0 / 12 0	7½	4
Needles Point	9 46	7½	3
Christchurch	9 0 / 11 30	5	
Poole	9 10 / 12 45	6½	3
Portland Breakwater	7 1	6¾	2¼
Bridport	6 5	11¼	4½
Exmouth	6 21	12¼	5¼
Torbay	6 0	13¼	6½
Dartmouth	6 16	14	6
Devonport Dock Yard	5 43	15½	7½
Plymouth Breakwater	5 37	15½	7½
Fowey	5 14	15	7½
Falmouth	4 57	16	8
Lizard	5 0	14¼	7
Penzance	4 30	16	8
Scilly Isles	4 30	20	10
England and Wales—West Coast.			
St. Ives	4 44	21	9½
Padstow	5 15	20½	12¼
Lundy Island (4)	5 15	27	13
Barnstaple (Bar)	5 30	19	9
Bideford	6 7	16	8
Ilfracombe	5 42	27¼	14½
Bridgewater Bar	6 50	35	18
Portishead	7 16	41¼	21½
Bristol (King Road)	6 56	44	22
Chepstow	7 30	50?	
Newport	7 10?	24?	
Cardiff	6 59	38	21
Swansea	5 56	30	15
Llanelly Bar	6 16	28	14
Tenby	6 0	27	13
Milford Haven (entrance)	5 52	22	
Pembroke Dock Yard	6 12	21	10
Cardigan (5)	7 1	14	
Aberystwith	7 31	13½	6½
Bardsey Island	7 40	15	
Caernarvon	9 33	13¾	7¼
Holyhead	10 11	16	8½
Beaumaris	10 32	21½	11¾
Chester	10 30	26	
Liverpool	11 23	26	14½
Formby Point	10 35	28	
Ribble Lighthouse	10 51	24	10
Fleetwood	11 11 / 11 12	27 / 26¼	15 / 14¼
Lancaster	11 16	8½	
Poulton-le-Sands	11 26	27¼	16
Piel Harbour (Pier)	11 5	28	14
Whitehaven	11 14	23¼	12¾
Workington	11 4	20	10
Maryport	11 3	18	8
Southerness	11 20	28	
Annan Foot	11 56	20	8
Port Carlisle	12 10	20?	8?
Isle of Man.			
Douglas	11 12	20¾	11¾
Ramsey	11 15	19¼	12½
Peel	11 8	16¼	9
Calf Sound	11 17	16¼	9¼
Port St. Mary	11 10	20	12
Castletown	11 10	20	12
Scotland, West Coast.			
Kirkcudbright	11 10	23	
Troon	11 50	10	5

Place.	High Water, Full and Change.	Range.	
		Sps.	Nps.
	h. m.	ft.	ft.
Port Patrick	11 10	15	9
Loch Ryan	11 12	11	
Campbellton	11 45	8½	4
Ayr	11 50	8¾	5
Ardrossan	11 45	10	6
Largs	11 50	10	
Greenock	0 8	9¾	6½
Port Glasgow	0 18	9	
Dumbarton	0 40	9	
Glasgow	1 25	2	
Burnt Isles, Kyles of Bute	11 50	10	6
Ardrishaig, Loch Fyne	11 53	9	6
Gigha Sound	2 22	4	1
Jura, East Coast	4 56	3½	1¼
Easdale Sound	5 25	10-12	
Crinan	4 49	6	1¾
Loch Aline	5 33	13¾	7
Oban	5 45	12	7
Loch Eil	5 15	13	5
Tobermory, Mull	5 36	13	5½
Portree, I. of Skye	6 32	15	6½
Kyle Akin	6 16	15	7½
Ullapool, Loch Broom	6 40	14½	6½
Poolewe, Loch Ewe	6 20	14½	6½
Berneray, Island of Harris	6 11	13	5
Stornoway	6 46	13	5¾
Cape Wrath	7 30	15½	
Thurso	8 28	14¾	6
Stroma, South side	9 47	9	4
Swona, East side	10 24		
„ West side	9 35		
Great Skerry, East side	11 4	9¼	3
Orkneys.			
Stromness	9 0	10	5
Kirkwall	10 9	10	5
Deer Sound	10 30	10	5
Widewall	9 3	10	5
Otterswick	9 13	11	5½
Shetland Isles.			
Balta	9 45	6	3
Lerwick	10 30	6	2
Scalloway	9 30	5¾	3½
Sumburgh Head	9 45		
Fair Isle	11 0	5	1
Scotland, East Coast.			
Duncansby Ness	10 14	10	4
Wick	11 22	9¾	5
Cromarty	11 56	14	8

Place.	High Water, Full and Change.	Range.	
		Sps.	Nps.
	m.	ft.	ft.
Inverness	12 18	12	7
Peterhead	0 34	10¾	5¾
Aberdeen	1 0	12	8
Montrose	1 25	13	7
Arbroath	1 35	14	8
Tay Bar	2 6	16	12
Dundee	2 32	4½	7¾
Leith	2 17	16½	9
Dunbar	2 8	15½	7
England, East Coast.			
Berwick	2 18	15	8
Tyne River Bar	3 20	14¾	8
„ Newcastle	4 23	10¼	
Sunderland	3 22	14½	7¾
Tees River, Bar	3 45	15	
Whitby	3 45	15	
Scarborough	4 11	15¾	8½
Flamborough Head	4 30	16	8
Humber Riv., Spurn Point	5 26	18¾	10¾
„ Hull	6 29	20¾	11¾
Lynn Deep, Sand	6 0	23	23
Cromer	7 0	14¾	7½
Yarmouth Haven	9 15	6	2
Lowestoft	9 56	6½	4
Orfordness	11 15	8	5
Woodbridge Haven, Bar	11 45	12	6
Harwich Harbour	12 6	11½	8
Orwell River, Ipswich	12 35	13½	
Gunfleet Sand, N.E. end	11 40	12	4
Ireland, Sou and East Coasts.			
Cape Clear	4 0	9	
Baltimore	4 23	10	6
Kinsale	4 43	11½	6¾
Queenstown	5 1	11¾	7
Ballycottin	4 54	12	7½
Youghal	5 14	12¾	7¼
Ballinacourty, Dungarvan	5 12	12½	6¾
Waterford (Duncannon Fort)	7 21	5	2¼
Wexford (6.)	7 21	5	2¼
Arklow	8 45	4	2
Wicklow	10 29	9	4
Dalkey Island	10 45	13	9
Kingstown	11 10	11	6½
Dublin Bar	11 12	13	7
„ Harbour	11 9	12	7
Balbriggan	10 40	11	
Dundalk	11 0	17	9
Carlingford, Bar	10 40	17	10

Place.	High Water, Full and Change.	Range.	
		Sps.	Nps.
	h. m.	ft.	ft.
Ardglass	11 0	16	8
Strangford, Bar	10 30	15	8
„ Portaferry	12 0	14	9
Ireland, North and West Coasts.			
Donaghadee	11 13	11¾	7
Belfast	10 43	9½	6¼
Lough Larne	10 30	10	6
Tor Point	9 40	9	4½
Ballycastle Bay	6 8	4	
Port Rush	6 8	5¼	2
Coleraine	6 24	6¼	2
Londonderry	8 1	7⅝	3¾
Rathmullen, Lough Swilly	5 42	12½	5¼
Sheephaven	5 25	12	5⅝
Gweedore Bay	5 32	11	5
Inishkeel	5 10	11	4½
Killibegs	5 31	11½	4⅝
Ballyshannon (Bar)	5 30	10	4
Sligo Bay	5 11	11¼	5¼
Killala Bay	5 22	10¼	5⅛
Broadhaven Harbour	5 0	10½	5
Achillbeg	5 14	10⅝	6¼
Westport	4 57	12⅝	6
Inishbofin	4 34	12⅝	7
Roundstone	4 28	13¼	6¼
Greatman Bay	4 39	15½	7½
Killeany, Arran Is.	4 28	13½	6½
Galway	4 35	14⅝	7
Liscanor Bay	4 23	13¾	6¼
River Shannon, Limerick	6 20	17	9¾
„ Foynes Is.	5 35	15½	8
„ Talbert	4 57	14½	7
„ Kilbaha	4 16	13	6½
Valentia Harbour	3 42	11	5½
Kenmare River (W. Cove)	3 52	10	5
Bantry Harbour	3 47	10	5¼
Castletown, Bearhaven	4 14	9¾	5¾
Black Ball Harbour	3 40	9½	5¼
Dunmanus Harbour	3 57	9½	5
Crookhaven	4 9	9¾	6
Skull	4 2	9⅝	5½
Cape Clear	4 0	9	
Norway.			
Lofoten Islands	12 0	9	6
Væro	12 0	9	6
Træ Islands	11 45	7	
Romsdals Islands	10 45	6	
Bergen	1 30	4	

Place.	High Water, Full and Change.	Range.	
		Sps.	Nps.
	h. m.	ft.	ft.
North Sea, E. Coast.			
Skagen or the Skaw	5 56	1	
Blaavand Point	1 44	5	
Hierting	2 45	5	
Eider, Tonning	2 1	9	
Elbe, Hamburg	5 29	6½	
„ Cuxhaven	1 8	10	
„ Entrance	12 0	11	
Helgoland	11 33	9	5
Weser, outer light-vessel	11 30		
Ems (outer buoy)	10 0	9	
Ameland Gat	9 0	7	
Terschelling (West)	8 40	6	4
Amsterdam	3 0	18	
Nieuwediep	7 27	4	3
Texel (outside shoals)	6 30	4	3
Brielle	3 0	5	
Hellevoetsluis	2 30	8	4
Flushing	1 20	15	
Ostend	12 25	19	11
Nieuport	12 18	16	12
France, North Coast.			
Dunkerque	12 8	16¾	12
Gravelines	12 0	19	11
Calais	11 49	19½	11¾
Cape Grisnez	11 27	21	12
Boulogne	11 25	25	14
Cayeux	11 6	27	15½
Dieppe	10 44	23	13
Fécamp	9 51	22	12½
Havre	9 29	23	11
Honfleur	8 51	17	9
Cherbourg	7 49	17	8
Alderney	6 46	17	8
Guernsey	6 30	25	14
Goury	7 6	22	13
Jersey, St. Aubin	6 21	32	14
Carteret	6 25	31	14
St. Germain	6 20	42	16
Régneville	6 20	35	17
Granville	6 13	37	17
Ile de Chausey	6 9	35	17
Cancale	6 20	37	17
Les Minquiers	6 6	35	17
St. Malo	6 5	35	17
Brèhat	5 51	31	16
Héaux Light	5 45	31	16
Tréguier	5 32	25	12
Plounanach	5 15	24	12
Moalaix Road	4 53	24	12
Ile de Bas	4 49	23	11
Abervrac'h	4 14	22	10
Ushant (7)	3 32	19¼	8¼

Place.	High Water, Full and Change.	Range.	
		Sps.	Nps.
France, West Coast.	h. m.	ft.	ft.
Brest	3 47	19	$8\frac{3}{4}$
Ile de Sein	3 21	$17\frac{1}{2}$	$7\frac{1}{4}$
Concarneau	3 12	13	$6\frac{1}{4}$
Port Louis, L'Orient	3 11	13	6
St. Nazaire	3 40	$15\frac{1}{4}$	$7\frac{1}{3}$
Ile de Noirmoutier	3 2	16	7
Ile d'Oleron	3 50	19	
Bordeaux	6 50	14	$11\frac{1}{2}$
Cordouan Lt.-house	3 37	$13\frac{3}{4}$	$7\frac{1}{3}$
Arcachon	4 37	$11\frac{3}{4}$	7
Boucaut, Adour Riv.	3 39	$8\frac{1}{2}$	5
Bayonne	3 45	12	8
Spain and Portugal.			
Port Passage	3 0	12	6
Bilbao	3 20	9	
Santander	3 30	15	9
Corunna	3 0	15	
Cape Finisterre	3 0		
Oporto	2 30	10	
Peniche	1 54		
Lisbon Bar	2 30	16	
Setubal	2 30	8	
Lagos	2 7	13	
Cadiz	1 45	$9\frac{1}{2}$	
Gibraltar, Old Mole (8)	2 20	$3\frac{1}{2}$	
Malaga	12 0	3	
Atlantic Isles.			
Funchal Bay, Madeira	12 48	7	
St. Michael, Azores	12 30	6	
Terceira ,,	12 32	$4\frac{1}{2}$	
Fayal ,,	11 45	4	
Bermudas, Ireland Island Dockyard	7 4	4	
Porto Praya	6 0?	5	
Sal, Cape Verde Ids.	7 45	5	
Puerto de la Luz, Gran Canaria	12 52	10	
Africa.			
Ceuta (9)	1 10		
Tangier	1 42		
Mogador	2 0	10	
Cape Bojador	12 0		
Cape Blanco	11 46	6	
Portendik	10 0	6	
Senegal	10 30		
Cape Verde	7 45	3	
River Gambia	8 10	6-9	
Bijouga Ids., Orango Channel	10 0	11	

Place.	High Water, Fall and Change.	Range.	
		Sps.	Nps.
	h. m.	ft.	ft.
River Nunez	10 0	15	8
Isles de Los	6 35	13	
Mellacoree River	7 40	11	
Scarcies Rivers	7 10	10	
Sierra Leone	7 55	8	
Banana Islands	8 15	9	
Gallinas River	6 45	4	
Monrovia	6 0	6	
Cape Palmas	4 30	4	
Grand Lahou	4 20	4	
Cape Three Points	4 0	4	
St. George d'Elmina	4 30	6	
Cape Coast Castle	4 30	6	
River Lagos	6 0	2	
,, Forçados	4 22	5	
,, Benin	4 15	7	
Niger, Nun entr.	4 8	6	
Bonny and New Calabar Rivers	5 0	9	
Cameroons River		6	
Fernando Po	4 0	7	
Princes Island	3 45	$4\frac{1}{2}$	
St. Thomas Island	3 25	$4\frac{1}{2}$	
Anno Bom Island	3 45	5	
Newfoundland (10).			
Little Mecattina	10 30	5	
New and Old Ferolle	11 45		
Bays of St. Genevieve & St. Barbe	11 30		
Isle Verte, or Green Island	9 0		
Bay of Pistolet	6 45	5	
Croque Harbour	6 30	$6\frac{1}{2}$	
Triton Harbour in Notre Dame Bay	6 0	6	
St. John's	7 30	5-7	
Placentia Harbour	9 15	8	
St. Pierre and Miquelon	9 3	6-7	
Between Cape Chapeau Rouge and Cape Ray generally	9 0	7-8	
Beyond Cape Ray, northward, the tide is inconsiderable.			
Labrador and Gulf of St. Lawrence.			
St. Lewis Cape	6 30		
Chateau Bay	7 35	$3\frac{1}{2}$	1
Red Bay	7 45	$3\frac{1}{2}$	$1\frac{1}{2}$
Bradore Bay	8 45	4	2
Belles Amours Bay	9 0	$4\frac{1}{2}$	$2\frac{1}{4}$
Kegashka Bay	10 45	5	3

Place.	High Water, Full and Change.	Range.	
		Sps.	Nps.
	h. m.	ft.	ft.
Clearwater Point	11 30	5	3
Mingan Harbour	1 16	7	4
Bay of Seven Ids.	1 40	9	5
Anticosti Id., W. pt	2 0	6	4
Point de Monts	12 0	12	
Chape Chatte	12 0	13	
St. Nicholas Harb	1 55	12	7
Bersimis River	2 0	12	7
Bic Island	2 15	14	8½
Saguenay, Tadousac	2 45	16	9½
River St. Lawrence. (11).			
Green Island	2 45	16	9½
Brandy Pots	3 6	17	10
Ile aux Coudres	4 25	17	10
Pillars	5 0	17	10
Quebec	6 38	18	13
Gulf of St. Lawrence.			
Magdalen Islands	8 20	3	2
Gaspé Basin	1 50	5	3
Point Macquereau	2 0	5	3
Campbell Town, Ristigouche River	4 0	10	7
Miramichi Bar	5 0	5	3
Richibucto River	3 30	4	2½
Point Escumenac	4 10	4	2½
Prince Edward Island.			
Cardigan Bay	8 40		
Hillsborough Bay	10 45	5	3¼
Bedeque Harbour	10 15	9½	7
Cascumpeque Harb.	5 40	7	5
Tracadie	7 0	3	2
		3½	2
Cape Breton Island.			
Sydney Harbour	9 0		
St. Anne Bay	8 34	5	4
		6	3
New Brunswick and Novia Scotia.			
Shediac Harbour	{ 1 0 / 8 0 }	4	2
Bay Verte	9 0	9	5
Pictou Harbour	10 0	6	4
Gut of Canso	9 15	4	2
Canso Harbour	7 48	6½	4½
Harbour Island	7 40	6½	4½
Ship Harbour	7 54	6½	4½
Jedore Harbour	7 45	6½	4¾
Halifax Harbour	7 49	6	4½
Sable Island, S. side	8 30	7	

Place.	High Water, Full and Change.	Range.	
		Sps.	Nps.
	h. m.	ft.	ft.
Sable Island, N. side	10 30	7	
Shelburne	8 30	8	
Bay of Fundy, Nova Scotia.			
East side, Cape Sable Island	8 0	7	4
Cape Sable	8 20	9	4½
Cape Sable, Seal Id.	9 0	12	6
Pubnico	9 3	12	5½
Tusket River	9 33	13	7
Jebogue	9 47	16½	6½
Yarmouth	10 11	16½	8¼
Cape St. Mary	10 30	19	9¾
West Port, Grand Passage	10 47	21½	10
Sandy Cove, East	10 39	22½	12
Annapolis	11 0	30?	
Gulliver Hole	10 51	26	13½
Digby Gut	11 2	28½	16½
Young Cove Point	11 14	32	18½
Port George	11 22	34	19½
Isle Haute	11 27	35½	20
Black Rock Lt.-ho.	11 36	37½	21
Spencer Anchorage	11 50	40¼	22
Parsborough W. Bay, Basin of Mines	12 4	45¼	25
Horton, do.	12 5	50	27¼
Bay of Fundy, New Brunswick.			
Cumberland Basin, Sackville	11 48	50	24
Cape Chignecto (12)	11 0	32	
Quaco	11 31	32	18
St. John	11 24	26½	12½
Campobello	11 20	25	12
West Quoddy	11 3	22½	10¼
Passamaquoddy	11 30	25	
Grand Harb., Grand Manan	11 1	17¾	11¼
Machias, Seal Ids.	10 58	13	10
United States.—Portland to New York.			
Mount Desert Id. (13)	11 10	13	
Portland*	11 25	10	7½?
Portsmouth*	11 23	9¾	7¼?
Newburyport*	11 22	9	6½
Salem*	11 13	10½	7½
Marblehead	11 30	12	
Boston Light*	11 12	11	8?
Boston (Charleston Yard)*	11 27	11¼	8?
Plymouth	11 30	11	

* From the Report of the United States Coast Survey, the times of High Water being the Corrected and not the Vulgar Establishment.

Place.	High Water, Full and Change.	Range. Sps.	Range. Nps.
	h. m.	ft.	ft.
Barnstable	11 0	9	
Cape Cod	11 30	13	
Monomy Point	11 30	6	
St. George Shoals	10 30	7	
Nantucket (14)	12 24	3½	2½
Edgartown*	12 16	2½	1½
Holmes Hole*	11 43	1¾	1½
Gay Head	7 37	7	
Tarpaulin Cove*	8 4	2½	2
Bird Island Light*	7 59	5¼	3½
New Bedford, entr.*	7 57	4½	2½
Newport*	7 45	4½	3
Point Judith*	7 32	3¾	2½
Montauk Point*	8 10	2¾	1½
Sandy Hook*	7 29	5½	4
New York*	8 13	5¼	3¼
Long Island Sound.			
Throgs Neck*	11 20	9¼	6
Sands Point*	11 13	9	6½
Oyster Bay*	11 7	9¼	5½
Bridgeport*	11 11	8	4¾
New Haven*	11 16	6½	5
New London*	9 23	3	2
Stonington*	9 7	3½	2
Watch Hill*	9 0	3	2½
Delaware Bay and River.			
Philadelphia*	1 18	7	5
New Castle*	11 53	7	6½
Mahons Rivers*	9 52	7	5
Cape Henlopen*	8 0	3-4	
Higbees, Cape May*	8 33	6¼	4
Delaware Breakwater*	8 0	4½	3
Chesapeake Bay and River.			
Richmond*	4 23		
James River*	2 14		
Baltimore*	6 33	1½	1
Cape Henry	7 40	4	
Annapolis*	4 38	1	
Point Lookout*	12 58	2	
Cape Charles	7 45	5	
Old Point Comfort*	8 17	3	2

Place.	High Water, Full and Change.	Range. Sps.	Range. Nps.
United States.—North Carolina to Texas.	h. m.	ft.	ft.
Hatteras Inlet*	7 4	2¾	1¾
Cape Hatteras	9 0	5	
Ocracoke Inlet	9 0		
Beaufort*	7 26	3¼	2¼?
Smithville*	7 19	5½	3¾
Cape Fear	7 0	7	
Georgetown	7 0	4	
Charleston*	7 13	6¼	4½?
Savannah*	3 13	7½	5½?
Cape Florida*	8 31	1½	1¼
Sand Cay*	8 40	2	¾
Cay West*	9 25	2⅓	½
Tampa Bay*	11 21	1¼	1
Pensacola		2	
Mobile		2	
Mississippi, S.W. pass		1½	
Galveston		4	
Gulf of Mexico.			
Vera Cruz		2	
Triangles		1½	
Campeche	1 42	2½	1½
Cape Catoucho	9 30	1	
Cozumel	8 30	1½	
Royal Harb., Ruatan	7 45	3½	
Cape Gracias Harb.	10 30	2	
Man of War Cay	8 10	2	
Blewfields	1 50	4	
Greytown	9 0	1¼	
West India Islands.			
Havanna, Cuba		3	
Cape Haytien, St. Domingo	6 0	3	
Gun Cay	8 30	3	
Abaco	8 0	3	
Nassau, New Providence	7 30	3-4	
Guinchos Cay	7 40	3	
Clarence Harbour, Long Island	8 30	4	
Exuma	7 20	2½	
Crooked Island	7 0	2½	
Inagua	8 0	3½	
San Juan, Porto Rico	8 2	1½	
Christianstäd, Santa Cruz	7 30	⅔	¼
Anegado	8 30	1¼	

* From the Report of the United States Coast Survey, the times of High Water being the Corrected and not the Vulgar Establishment.

REMARKS ON THE TIDE TABLE.

(1.) **River Thames.**—During strong north-westerly gales, the tide marks high water earlier in the River Thames than otherwise, and does not give so much water, whilst the ebb tide runs out later, and marks lower; but, upon the gales abating and the weather moderating, the tides put in and rise much higher, whilst they also run longer before high water is marked, and with more velocity of current, nor do they run out so long or so low.

(2.) **English Channel.**—The tides of the English Channel were but imperfectly understood till Rear-Admiral Beechey, R.N., investigated a mass of observations which had been made about the year 1817, and which demonstrated that there was a great resemblance in the characteristics of the tidal phenomena of the English and Irish Channels, and this investigation led to a more extensive series of observations throughout the English Channel, which were also discussed by Admiral Beechey. From his valuable contribution to science and the mariner in the "Philosophical Transactions" for 1848 and 1851, we make the following extract:—

Instead of the progressive changes of stream turning progressively later as the tide advances up the strait, they cease at a certain point, which is in the English Channel, between the Start and Gulf of St. Malo; and in the North Sea, between the Texel and the Estuary of Lynn; and between these spots there is a tide peculiar to the channel, quite distinct from that of the seas on either side of it, which are always running in contrary directions.

When these streams meet, the tide is ever varying in its direction, according as the strength of one stream prevails over that of the other, giving to the water a rotary motion, without scarcely an interval of slack water; while in the space between them the tide sets steadily *towards* Dover, while the water is *rising* there, and *away* from it while it is *falling* at that place. This "*true Channel stream*" is about 180 miles in extent in either direction, from the point of union of the tides in the Strait of Dover to the region of rotatory tides off Lynn, and off the Start and St. Malo.

As the true channel streams are always running in opposite courses, there is necessarily a point where they meet and separate, and this occurs in the Strait of Dover. But *in this strait* the stream, although it first obeys one tide and then another, does not slack with the channel streams, but is found to be still running at high and low water on the shore, at which times those streams are at rest, so that the Strait of Dover never has slack water throughout its whole extent at any time. I have, in consequence, called this an *intermediate* tide.

The limits of neither of the streams appear to be stationary, but *range to and fro* as the tide rises and falls *at Dover*, travelling to the *eastward on both sides*, and at high and low water suddenly shifting 60 miles to the westward to recommence their easterly course with the next tide; and although so far apart, they possess the remarkable peculiarity of shifting together, so that the channel streams preserve, as nearly possible, the same relative dimensions.

In the Strait of Dover this line of meeting and of separation, oscillates between Beachey Head and the North Foreland, a distance of about 60 miles. When the water on the shore at Dover begins to *fall*, a *separation* of the Channel streams begins off Beachey Head. As the fall continues, this line creeps to the eastward; at two hours after high water it has reached Hastings; at three hours, Rye; and thus it travels on, until at low water by the shore it has arrived nearly at the North Foreland on one side of the strait, and at Dunkirk on the other. At this time the *Channel streams* on both sides slack, but in that portion which I call the *intermediate* stream, in the Strait of Dover, the water is still running to the westward; and when the new *Channel* streams make, as the water rises on the shore, this *intermediate* portion is found to unite with, or to oppose, one or the other of these streams, according as it was before the reverse; so that, as before mentioned, the line of meeting at low water appears off Beachy Head to recommence its easterly course. This *intermediate* stream forms a remarkable feature in the tidal system of the Channel; it is well established, as the line of meeting and of separation occupies a very limited space, and it seems to be entirely due to the contracted form of the Channel in this immediate locality preventing the free escape of the water.

Admiral W. Bullock, in order to test the point of separation, anchored two vessels a mile apart between Beachy Head and Dungeness; and found both vessels at the same time to ride with their heads in opposite directions in obedience to the streams, which were then running opposite ways.

The *Channel stream*, which I have described as running between the intermediate stream and the rotatory or mixed streams at the outer extremities of the Channel, pursues a steady course along the main trunk of the strait, slacking only towards high and low water at Dover, when it is preparing to invert its course; and, contrary to the generally received opinion of a *progressive slack water* in a strait having a progressive establishment, this stream has the peculiarity of slacking throughout its whole extent at *nearly the same time;* and this time, as was anticipated in my former paper ("Phil. Trans.," 1848), corresponds nearly with the time of high and low water on the shore at Dover, the site of the combined wave, and the *virtual head of the tide.*

A simple rule thus suffices to guide the sailor up the main Channel stream It is, that *the stream runs toward Dover while the water is rising there, and away from it while falling.* The tidal hours for Dover, therefore, answer for the whole of the Channel.

(3.) **Southampton, &c.**—This port has the singular advantage of having two high waters, which adds not a little to its dock facilities. The same phenomena is also found in other places within the Isle of Wight, and is owing to the channel tide passing round either end of the Isle of Wight, and arriving at the point a different times.

It will be observed that at Poole the rise and fall is insignificant, while on the opposite side of the channel we have the gigantic tides of the Bay of St. Malo, a similar feature to that which is found in the St. George's Channel.

(4.) Bristol Channel.—The tides of the Bristol Channel are remarkable for their magnitude and rapidity. There are few places in the world where they are exceeded. The Bay of Fundy, Nova Scotia, and the Bay of Mont St. Michel, on the French coast, are somewhat analogous. The effect of these rushing waters is to alter the channels and shift the banks in the upper portion of the Bristol Channel in a most extraordinary manner. Some idea is given in our Directions for the Bristol Channel.

Without the Bristol Channel spring tides rise from 22 to 24 and 26 ft.; but as that channel narrows, or contracts in its breadth, the velocity and vertical rise increase in proportion; and so much that, in King Road, it rises to the height of 8 fathoms.* Between Nash Point and Bridgewater Bay, past Hurlstone Point, &c., the tide sets with great velocity over the Culver Sand, into Bridgewater Bay and River. Through Caldy Sound, the stream from Caermarthen Bay makes westward nearly two hours before the *flood* has done running without the island; and the stream makes eastward through the sound, as well as between the Helwick Sand and Worm's Head, nearly two hours before the channel ebb ceases.

At *Lundy Island* ordinary spring tides rise 27 feet, equinoctial springs 31 feet, and neaps 13 feet. In *Barnstaple Bay*, ordinary springs rise 25 feet, equinoctial 28 feet, and neaps 15 feet. In this bay, at from 2 to 3 miles from shore, a gentle stream sets to the eastward, from the time of low water to four hours' flood, and then to the westward until low water again. In mid-channel between this bay and Lundy Island, the streams of flood and ebb set tide and tide each way, according to the time of flowing on the shore, at the rate of 3 miles an hour on springs and 2 upon the neaps, allowing half an hour for slacking and veering out.

It should be understood that, within the range of Swansea Bay and its offing at about 5 miles West of the Scarweathers, the first-quarter flood sets directly toward them; after which and until half-flood, it sweeps 1 mile outside, nearing the West end of the Nash Sands; and ultimately setting, till high water, S.S.E. by compass, which points well outside of all. It averages a rate of 4 and 5 knots on springs, and 3 upon neaps, and changes exactly at the same time that it ceases to rise on the shore; but slack water always lasts half an hour.

It has been observed, that over the shoals, and through the different channels, the velocity of the tides is greatly increased, and there is reason for believing that on springs the rate is nearly 6 knots.

There is always a strong tide under these shoals, which is, of course, increased or decreased according to the vertical rise. This is of consequence when working up near them, as some advantage may, in the daytime, be taken of it, by keeping on the proper side. Its influence will be manifest to any vessel thus situated, as she would nearly make her course good when under their lee, but be swept away furiously on opening the different passages.

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* Captain Andrew Livingston, of Liverpool, a gentleman to whom we have been much indebted for many valuable and useful communications, has informed us that he actually measured fully 50 feet rise of water, in November, 1813, at King's Road, in a spring tide. At Chepstow, above, on the opposide side, the vertical rise of a spring tide is not uncommonly 60 feet and even 72 feet.

Should it be desirable to have the true tide, it will therefore be requisite to keep on the North or South side of all the shoals, according to the ebb or flood.

(5.) St. George's Channel.—Much that has been said of the English Channel tides is applicable to those of the St. George's Channel.

In the St. George's or Irish Channel, experiments have shown that, notwithstanding the variety of times of high water throughout the channel, the turn of the stream over all that part which may be called the fair navigable portion of the channel is nearly simultaneous; that the northern and southern streams in both channels commence and end in all parts (practically speaking) at nearly the same time; and that time happens to correspond nearly with the time of high and low water on the shore at *the entrance* of Liverpool and of Morecambe Bay,* a spot remarkable as being the point where the opposite tides, coming round the extremities of Ireland, terminate. So that it is necessary only to know the times of high and low water at either of these places to determine the hour when the stream of either *tide will commence or terminate in any part of the channel.* For this purpose the Liverpool tide table may be used, subtracting 16′ from the times there given, in consequence of the Canning Dock being later in its high water than the point which is considered the head of the tide.

The tide from the Atlantic enters the St. George's Channel by two channels; of which Carnsore Point, the S.E. point of Ireland, and St. David's Head, the S.E. point of Wales, are the limits of the southern one; and Rathlin and the Mull of Cantyre the boundaries of the northern.

The *central portion of the stream* of flood, or *ingoing* stream runs nearly in a line from a point midway between the Tuskar and the Bishops, to a positition 16 miles due West of Holyhead; beyond which it begins to expand eastward and westward; but its main body preserves its direction straight forward towards the Calf of Man and on towards Maughold Head. Here it is arrested by the flood or southern stream from the North Channel coming round the Point of Ayr, and is first turned round to the eastward by it, and then goes on with it at an easy rate direct from Morecombe Bay; thus changing its direction nearly eight points.

The *outer portions* of the stream are necessarily deflected from the course of the great body of the water by the impediments of the banks on the Irish side of the channel, and by the tortuous form of the coast on the Welsh. The eastern portion rushes with great rapidity between the Smalls, Grassholm, and Milford Haven towards the Bishops, which it passes at a rate of between 4 and 5 knots; sets sharply round those rocks in an E.N.E. direction, right over the Bass Bank, and into Cardigan Bay; makes the circuit of that bay, and sets out again towards Bardsey, at the other extremity of it; the streams still continuing outside towards the South Stack, which it rounds, setting towards the Skerries at a rate of upwards of 4 knots; and, finally, turns sharp round those rocks for Liverpool and Morecambe Bay;

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* The entrances of Liverpool and of Morecombe Bay (Fleetwood) are, as before stated 16 minutes earlier in their times of high water than those given for Liverpool in the Tide Tables.

completing in its way the high water in the Menai, and filling the Dee, the Mersey, and the Ribble.

The *western portion of the stream*, after passing the Saltees, runs nearly in the direction of the Tuskar, sets sharply round it, and then takes a N.E. ½ N. direction, setting fairly along the coast, but over the banks skirting the shore; so that vessels tacking near the inner edge of the sands on the flood, and on the outer edge on the ebb, have been carried upon them and lost, especially upon the Arklow and Codling Banks. Abreast of the Arklow is situated that remarkable spot in the Irish Channel, where the tide scarcely rises or falls. The stream, notwithstanding, sweeps past it at the rate of 4 knots at the springs, and reaches the parallel of Wicklow Head. Here it encounters an extensive projection of the Codling Bank; and while the outer portion takes the circuit of the bank, the inner stream sweeps over it, occasioning an overfall and strong rippling all round the edge, by which the bank may generally be discovered. Beyond this point the streams unite and flow on towards Howth and Lambay, growing gradually weaker as they proceed, until they ultimately expend themselves in a large space of still water situated between the Isle of Man and Carlingford. There we have not been able to detect any stream; for there another remarkable phenomenon occurs—the water rising and falling, without having any perceptible stream. This space of still water is marked by a bottom of blue mud. Such is the course of the flowing water at the Southern Channel.

In the North Channel the stream enters between the Mull of Cantyre and Rathlin Island simultaneously with that passing the Tuskar into the Southern Channel, but flows in the contrary direction. It runs at the rate of 3 knots at the springs, increasing to 5 knots near the Mull, and to 4 near Tor Point, on the opposite side of the channel. The main body sweeps to the S. by E., taking nearly the general direction of the channel, but pressing more heavily on the Wigtonshire coast.

The *central portion* midway between the Mull of Galloway and the Copeland Islands presses on towards the northern half of the Isle of Man; and while one portion of it flows towards the Point of Ayr, the other makes for Contrary Head, and is there turned back to the N.E. at a right angle nearly to its early course. Passing Jurby Point, it re-unites with the other portion of the stream, and they jointly rush with a rapidity of from 4 to 5 knots round the Point of Ayr, and directly across all the banks lying off there, and catching up the stream from the South Channel off Maughold Head, they hurry on together towards that great point of union, Morecombe Bay. This bay, the grand receptacle of the streams from both channels, is notorious for its huge banks of sand, and also remarkable for a deep channel scoured out by the stream, and known as the Lune Deep, which is the great haven to all vessels bound to Fleetwood. &c.

Such is a general description of the streams in the Irish Channel, which are produced by the flowing of the water, or which for the purpose of distinction, we may designate the *ingoing streams*.

The ebbing or *outgoing streams* do not materially differ from the reverse of those, except that in the Southern Channel they press rather more over towards the Irish coast.

(7.) **Bay of Biscay.**—On the coasts of the bay, the tidal wave advancing from the westward, makes high water almost at the same hour all around its shores; and the range also does not vary greatly.*

(8.) **Strait of Gibraltar.**—In the middle of the Strait of Gibraltar the *current mostly* and generally sets to the East; but on each side the flood tide sets to the westward. On the European side, West of the Isle of Tarifa, it is high water at eleven o'clock, but the stream without continues to run until two o'clock. On the opposite shore of Africa, it is high water at ten o'clock, and the stream continues to run until one o'clock; after which periods it changes on either side, and runs eastward with the general current. Near the shores are many changes, counter-currents, and whirlpools, caused by, and varying with, the winds.

(9.) **Africa.**—The currents on the African coast (hereafter explained) render the given times of high water uncertain.

Between Cape Cantin and Cape Blanco they are strong, and set as shown on the chart.

In the road without the Senegal, the current sets chiefly to the S.W. From the bar, strong freshes come down after the rains, and a powerful current of fresh water sets from the river to some distance out to sea.

In the Bay of Yoff, to the N.E. of Cape Verde, the currents set rapidly, and sometimes in very dangerous whirls.

At the mouth of the Gambia the greatest rise in the dry season is not more than 6 ft. Here the tide continues to run on the surface for an hour and a half after it ceases flowing on the shore.

The level of the sea, in the vicinity of Cape Coast Castle, is higher, by at least 6 ft., in the rainy season (which is the season of the strong S.W. and southerly winds, between April and September), than in the more serene weather of the dry season.

In the rainy season, or S.W. monsoon, trunks of trees are frequently carried on shore, and found at 6 or 8 feet above the level of the sea, of the other season; and the tides *ebb* and *flow* regularly in the several rivers; but, in the dry season, the same rivers run ebb constantly; the level of the sea being then too low to allow the tide-waters to enter the mouths of the rivers.

Some remarks on the tides about Cape Blanco, the Channels of the Bissagos, &c., are given in the Description of the Coast hereafter.

(10.) **Newfoundland.**—On the coasts of Newfoundland the tides are very irregular; being greatly influenced by the prevailing wind. On all the eastern coast they have nearly the same rising; springs about 6 ft., neaps 4. At the entrance of St. John's they set-in in a *bore*.

Between Cape La Hune and Cape Ray the flood sets to the westward in the offing very irregularly, but generally two or three hours after high water on shore. See more particularly our "British American Navigator."

(11.) **River St. Lawrence.**—At 3 leagues below *Tadousac*, or the *Saguenay*,

* Commander Gorringe, U.S.N., when examining the bank he discovered in 1876, lying 130 miles West of Cape St. Vincent, found the tides setting regularly N.E. and S.W., at the rate of $1\frac{1}{2}$ mile an hour.

is the eddy of the flood, and the stream on the surface always sets thence downward. Off Tadousac, the tide ebbs six hours eight minutes. Both streams here run three-quarters of an hour after high water. At Green Island it ebbs six hours twenty-four minutes, and flows six hours.

At the Isle aux Coudres it ebbs six hours twenty minutes, and flows six hours. Here the ebb stream continues an hour and a quarter after low water, and the flood three-quarters of an hour after high water. Within the Pillars, off St. Jean, the tide ebbs six hours fifty minutes, and flows five hours twenty-five minutes. Both streams continue to run an hour after high and low water by the shore, but they are influenced in duration by strong winds.

At the Isle of Orleans the stream ebbs seven hours, and flows five hours twenty minutes. At Quebec it flows four hours forty-five minutes only, but an hour longer as above.

From Green Island to Quebec the tides rise irregularly, but very considerably. From Coudre to Quebec the water falls 4 ft. before the tide makes down. At the Isle of Coudre, in spring tides, the ebb runs at the rate of 2 knots. The next strongest ebb is between Apple and Basque Isles; the ebb of the River Saguenay uniting here, it runs full 7 knots in the spring tides; yet, although the ebb is so strong, the flood is scarcely perceptible; and below the Isle of Bic there is no appearance of a flood tide.

(12.) **Bay of Fundy.**—Off Cape Sable the tide runs at the rate of 3, and sometimes 4 miles an hour; and in the Bay of Fundy the tides are very rapid. Cape D'Or and Cape Chignecto are high lands, with very steep cliffs and deep water close under them. The same kind of shore continues to the head of Chignecto Bay, where very extensive flats of mud and quicksands are left to dry at low water. Here the tides come in a bore, rushing in with great rapidity; they are known to flow at the equinoxes from 60 to 70 ft. perpendicular; and it is remarkable that, at the same time, they rise in the Bay Verte, on the northern side of the isthmus, only 8 ft.

(13.) **Mount Desert Rock.**—At Mount Desert Rock the stream of flood divides to run eastward and westward. With the Skuttock Hills about N.N.E., and within 4 or 5 leagues of those of Mount Desert, the flood stream sets E.N.E., and the ebb W.S.W.; but, at the distance of 9 or 10 leagues from the land, the current, in general, sets to the S.W. and more westward. From the Mount Desert Rock to the Fox Islands, at the entrance of the Bay of Penobscot, the flood stream sets W.S.W. along shore; but it nevertheless runs up to the northward into Isle Haute Bay, &c.

(14.) **Nantucket, &c.**—Off this island and its vicinity is that remarkable but dangerous collection of shoals, which are so well known to all who navigate these waters. Their form and situation, and also the peculiarities of the Cape Cod peninsula, lead to the inference that there is some singular effect of the tides and currents hereabout to which these peculiarities are owing. This subject has been partially investigated by the United States Coast Survey.

"The region about Nantucket and Martha's Vineyard is the dividing space between the cotidal hours of xii. and xv., and in this locality the combination of two apparently distinct tide-waves is observed. This combi-

nation presents the most singular forms, giving at times four high tides in one day near the junction of Nantucket and Martha's Vineyard Sounds, and distorting the tide-wave generally, not only in these sounds, but also on the open sea-coast of Nantucket and Matha's Vineyard and Islands, and in Muskeget Channel.

"The great disturbance of the ocean level thus produced gives rise to those remarkable currents so peculiar to this neighbourhood, and so disastrous to commerce."

(15.) Florida, &c.—Near Cay West, on the Florida Reef, the tides are, in some measure, regular within the reef; the flood setting to the westward, and the ebb contrary. To the westward, between the Tortugas and Cayo Marques, the flood sets variably through to the northward, and the ebb to the E.S.E.

It is remarkable that, on the South side of these kays, the flood comes from the south-eastward; but on the North side of them, all the way from Kay West, the flood runs to the eastward, along the edge of the bank, and to the southward, through the little channels, in order to fill up the intermediate bays and lagoons, with the assistance of the flood from the southward.

Westward of Cay West there is a general current to the south-westward, along the reef, and to some distance to the South side of it.

In Chatham Bay it runs tide and half-tide; viz., three hours flood, then three hours ebb; next nine hours flood, &c. Here, in some places, it is a mere fall; but in some of the channels it is as much as four men can do to stem the current with a boat.

During a S.E. gale or storm, the water in the bays and rivers of West Florida has been known to rise 7 feet perpendicular, and vessels of burden have been driven in among the pine trees, at some distance from shore.

From Cape Roman, northward and westward, the tide seems to ebb and flow only once in the twenty-four hours; but it is irregular, and much governed by the winds. Yet the effects in a dry season are very perceptible in the rivers at a distance from the sea.

(16.) Bahamas, &c.—Although at the Bahamas the rise and fall are inconsiderable, the tide of flood sets an indraught on the northern part of the Little Bahama Bank from every point of the compass, which renders an approach very dangerous. The tide sets with some force directly on and off the western side of the Grand Bank of Bahama; particularly at the full and change of the moon. High water at half-past seven or thereabout. Rise, 3 or 4 feet. On the Middle Ground of this bank the tides set in every direction.

In Providence N.W. Channel the current runs generally to the eastward, about 2 miles an hour.

Near Egg Island, to the N.W. of Eleuthera, it is, however, uncertain, and great attention should be paid to the lead. In the passage within Egg Island the tide runs at the rate of 4 miles, and rises about 4 feet, the flood setting eastward, and strongly over the reefs.

About the Berry Islands and Providence the water rises 2 ft. higher when

the sun comes to the northward of the line, than it does when the sun is to the southward, and its strength is in a similar proportion. Here and at the Bomini Isles the flood sets to the N.E.

III.—OF THE CURRENTS.

(159.) **GENERAL REMARKS.**—A *Current* is to be understood to be a stream on, or a particular set in the direction of, the surface of the sea, occasioned by winds and other impulses, exclusive of (but which *may be influenced by*) the causes of the tides. It is an observation of *Dampier*, that *currents* are scarcely ever felt but at sea, and *tides* but upon the coasts; and it is certainly an established fact that currents prevail mostly in those parts where the tides are weak and scarcely perceptible, or where the sea, apparently little influenced by the causes of the tides, is disposed to a quiescent state. This will be obvious by an attentive consideration of the following descriptions. The necessity of attention to the silent, imperceptible, and therefore dangerous operation of currents, will be equally apparent.

(160.) The usual method of estimating the existence, direction, and velocity of a current, as is well known, is the comparison between the observed position of a ship and that obtained by dead-reckoning. It may be as well to observe in the outset, that this only method of observation involves some amount of fallacy, as a current will be the general receiver of all errors or imperfections of observation, and beyond doubt the strength of currents has been frequently exaggerated from this very cause. Now, as the latitude is attained far more easily and accurately than the longitude, it follows that this exaggeration has been chiefly shown in those currents supposed to move to East and West. Still, by combining a large number of observations, we may safely conclude that they will neutralize each other's errors, and afford something like an accurate conclusion.

(161.) We have an excellent repository of a vast number of current observations in the elaborate charts of Major Rennell, a great mine for facts in surface current theory. Commander Maury's charts, and the more recent ones of our Meteorological Office, likewise afford a great addition to our stock of knowledge. This is also increased by numerous detached observations scattered through many works. All these, as far as attainable, have been integrated at a great expenditure of labour, in the chart of the North Atlantic Ocean, which this work particularly elucidates.

(162.) But since that chart was constructed a much more extensive series of observations have been incorporated with those just named, in a set of charts, one for each month of the year, published by the Meteorological Department of the Board of Trade in March, 1872. They were contained in the first 800 registers collected by that office, and were reduced by Mr. R. Strachan. Some idea of the amount of labour which was required to accumulate these observations may be gathered from the fact that the number of them exceeded 7,500, each of which took 24 hours to make. In addition to these the whole of the available data in Rennell's and Maury's charts have been integrated with them, and thus we have a far more perfect

NORTH
ATLANTIC OCEAN
CURRENTS
HUDSONS BAY
DAVIS STRAIT
GREENLAND
ICELAND
Reykanes
Faroe Is.
Shetlands
Orkneys
Currents uncertain
Drift wood
NORTH SEA
ENGLISH CHANNEL
PARIS
BAY OF BISCAY
SPAIN
MEDITERRANEAN SEA
Azores
St Michael
St Vincents
Sts of Gibraltar
Madeira
Canary Is.
Cape Verde Islands
Bonavista
Fogo
Trade of Cacao
NORTH EQUATORIAL CURRENT
Equator
UNITED STATES
Bermudas
GULF OF MEXICO
CARIBBEAN SEA
ANTILLES
PACIFIC OCEAN
SOUTH AMERICA
Galapagos
Marañon
Pernambuco
Cape Frio
Rio Janeiro
Bahia
Bight of Benin
Bight of Biafra
St Thomas
Gaboon
Cape Negro
Cape Roque
Fernando Noronha
Trinidad
Tobago
Barbadoes
Martinique
Guadaloupe
Jamaica
Hispaniola
Cuba
Bahama Is.
Hudson Str.
Davis Str.
Baffins Bay
Greenland Current
Labrador Current
Gulf Stream
Newfoundland
Nova Scotia
Canada
Quebec
Montreal
Halifax
Boston
New York
Philadelphia
Washington
Charleston
Savannah
Mobile
New Orleans
Tampa Bay
Havana
Yucatan
Campeachy
Honduras
Caracas
Orinoco
Amazon
Rio de la Plata
Falkland Is.
Terra del Fuego
Cape Horn
Magellan Str.
Valparaiso
Lima
Panama
Acapulco
Mexico
Cape Florida
Cape Hatteras
Cape Cod
Cape Race
Cape Farewell
Cape Chudleigh
Cape Walsingham
Cape Charles
Cape Henry
Cape Fear
Cape Finisterre
Cape St Vincent
Cape Verde
Cape Blanco
Cape Bojador
Cape Nun
Cape Spartel
Cape Bon
Cape Matapan
Cape Colonna
Cape Passaro
Cape Corso
Cape Palmas
Cape Lopez
Cape Negro
Cape Frio
Cape Horn
Cape Roque
Cape Blanco
Cape Bojador
Cape Nun
Cape Spartel
Cape Bon
Cape Matapan
Cape Colonna
Cape Passaro
Cape Corso
Cape Palmas
Cape Lopez
Cape Negro
Cape Frio
Cape Horn
Cape Roque

view of the Atlantic currents, between the equator and 40° N., and from the African coast to the Gulf of Mexico than has been attainable before. A portion of the information then collected was published by Admiral FitzRoy in 1859 on the Board of Trade Wind Charts, which showed the phenomena for the months of February, May, August and November, being the middle month of each seasonal quarter.

(163.) In this book, limited as it necessarily is to generalities, space could not be afforded to give the introduction of these monthly charts, but in the subsequent descriptions of each branch of ocean circulation in the North Atlantic we shall add the notes which elucidate the current charts, and which also have been drawn up by Mr. R. Strachan.

In pursuing these calculations it was found that in many localities the currents were represented as most devious and erratic, frequently of great strength, and yet on a mean, showing that there was no continued set of the waters in any special direction. The diagrams of the direction of the wind at the Liverpool Observatory, page 250, in their more complicated parts, give a good notion of their motions, as their paths, when traced, resemble each other much. In other parts, as in the great Equatorial Current, the motion, as estimated, is remarkably uniform, and this demonstrates that these observations generally are entitled to confidence.

(164.) In founding any theories of circulation or movement of the ocean waters upon the basis of the acknowledged to be, imperfect observations used by Major Rennell, it may be objected that many of them are now old, and therefore still less trustworthy. To this it may be replied, that they were mostly taken in *wooden* ships by careful navigators in an age when great pains was taken with the dead-reckoning. A doubt may very fairly be expressed whether the observations of an equal number of modern ships would give us trustworthy results. Modern speed, less attention to D.R., more refined astronomy superseding it, and above all, the greater quantity of iron in modern ships, which, acting on the compass, will inevitably tend to invalidate the most carefully kept log, will all tend to give confidence in these old observations.

(165.) There is one general result in discussing any large number or collection of current observations. They show that the surface water moves at a much lower velocity than has been attributed to current motion generally. Perhaps this may in some degree arise from the fact that only those of remarkable strength have been selected, without properly taking into account the greater number of observations which would give a much more moderate rate. Thus Major Rennell estimated the Gulf Stream to move in the narrows at from 82 to 96 and 120 miles per day. A more rigid calculation of his and other older data gives 65·4 miles per day as an annual average. And this last estimate is much reduced by the more rigid investigation which has been carried out by the Meteorological Office in 1872, which gives a mean annual rate of only 48 miles per day.

(166.) **Bottles.**— It has been a well-known practice for many years to send these floating messengers as indicators of currents. In 1843, Captain A. B. Becher, R.N., drew up a very interesting chart of the North Atlantic with the points of "despatch and arrival" of a very large number of these current bottles. The practice and the accuracy of the teaching of these bottles led

to a long controversy, which, however, certainly did not tend to overturn their authority, so it need not be longer adverted to here, than to say that the principal objection to them was, that they were rather impelled by the prevailing wind than drifted in the current. But this is also a demonstration of what can be otherwise proved, that the wind and surface currents of the Atlantic and other oceans obey the same law, and move very much in the same circuits. These bottles, then, will form an important part of the subsequent demonstrations of the direction and rate of currents. The chart of Captain Becher's alluded to, bears intrinsic evidence of its trustworthy character, as in each region the bottles obey precisely the law which would, *à priori*, be laid down for them.

Further speculations as to the causes of the currents, and the general view of their circulation and character, is reserved to the end of this section.

(167.) It may be observed that this section deals chiefly with the *surface currents* of the Atlantic, as that is the only feature which affects navigation. But this superficial action is not the only point to be considered in relation to ocean currents, as it will not explain many phenomena known to exist. The researches which have been carried on in H.M. ships *Lightning* and *Porcupine* in 1868-70, and *Challenger*, 1873—1876, under the superintendence of Dr. Carpenter, Mr. Gwyn Jeffreys, F.R.S., and Professor Wyville Thomson, LL.D., F.R.S., have thrown much light on the temperature, condition, and probable movements of the lower beds of ocean water, which will be hereafter alluded to. Indeed, this may be considered as a new branch of terrestrial physics, from which many most important facts will be derived.

(168.) That the waters of the ocean do circulate over and intermingle with every portion of the water-surface of the globe is certain. Its composition and character are everywhere, in every region, exactly the same. This universality of character can only be accounted for by inferring that the ocean waters are continually being intermingled, as is the case with the atmosphere, as before described (2.) page 173.

It may be objected that the specific gravity of the *surface* water varies considerably in different regions, and that it is therefore an argument against this intermingling of the sea waters. But it will be found that there are local causes which affect the saltness of the surface water. In the Arctic regions, where it is frequently found of great density or increased saltness, it is doubtless caused by the formation of ice, subtracting the fresh water from the surface. Again, in the equatorial regions, it is usually found of low specific gravity, or containing less salt, which may also be accounted for by the great rain-fall which, by intermingling the light fresh water with the surface, lowers its density. Very much speculation has been used on this variation in the surface density and on its dynamic effects, in producing currents and other phenomena.

But it is deferentially urged against this reasoning, that almost all the experiments made upon the density of the water at any considerable depth (above 20 or 30 fathoms) show a remarkable uniformity in the density in all regions (1·027), as will be shown in a later part of this book, and that, therefore, the real character of sea water, *below* local influences, is everywhere nearly the same.

(169.) But we have remarkable proofs that not only the upper strata, but also the whole ocean to its bed is of one universal character. One may be cited. During the voyage of H.M.S. *Bulldog*, in the summer of 1860, for the purpose of obtaining the deep-sea soundings between England and Labrador, for the electric telegraph cable, when nearly midway between Ireland and Greenland, they brought up from the depth of 1,260 fathoms that is nearly 1½ statute mile, several *live starfish*, which had clasped their slender arms round that part of the sounding line which lay on the bottom. Now, as the process of winding this line in would occupy upwards of an hour, and these delicate animals having passed through the strata still *attached* and *alive*, it follows that had the water varied in character even in a slight degree, that they would have loosened their hold and have died.

It is needless to pursue this subject further now. It will be found more amplified hereafter, when the question of the depth of the Atlantic is discussed. It is only here cited in order that should the mariner in the course of his voyage be able, from his observations, to add to the knowledge of this interesting but new subject, it will afford him great interest, and be beneficial to the rest of the world.

(170.) The subject of the *temperature* of the ocean will be treated of specially hereafter. It is of importance in some localities, as it will indicate the changing from one current to another, as from the Gulf Stream into the cold Arctic current within it, or the reverse. It was formerly thought that a decrease of temperature was a sure indication of approaching shoal water, and its study was therefore inculcated as a precautionary measure. This point, however, has been shown to be in general fallacious. It arose from the fact that vessels crossing the Gulf Stream, or attaining soundings on the American coast, experienced a very sudden decrease of heat in the water. This is now accounted for in a very different way, therefore this topic is not of so much importance in the practice of navigation as was formerly thought.

(171.) Leaving for a future page the remarks on the origin and causes of ocean currents, it may be here briefly remarked that the action of the wind seems to be a main cause of the general surface circulation. Doubtless there are several other forces which combine with or help to neutralize the action of the wind, such as the tidal wave, the differing effects of temperature, of specific gravity on the surface and of the very difficult subject of wave-action which should be taken into consideration. But the tiny ripple raised by a breath of air on the surface of still water, enlarged by accumulation into an oscillating wave by a more powerful wind, may be driven forward into a wave of translation, and thus the wind becomes the real origin of a drift and finally a stream current, and this can be satisfactorily traced over a great portion of the ocean surface.

(172.) There are many evidences that the surface currents, which alone control a ship's movements, have but very little depths. A very few fathoms below the surface their velocity and power become much decreased, and it is more than probable that at a moderate depth compared with the dimensions which have been usually attributed to them, they cease altogether or become

imperceptible to ordinary means of measurement. This has been found to be eminently the case in the experience gained in laying submarine telegraph cables. If the motion of the surface water were continued to any great depth, or if there were changeable and varying sub-surface streams, it would very greatly interfere with the success of these enterprises, but no such obstacles have shown themselves to be of any magnitude.

(173.) *Of Currents* there are two distinctions:—1. The *Drift Current;* 2. The *Stream Current.*

The *Drift, or Drift Current,* is the mere effect of a *constant* or *very prevalent* wind on the surface water, impelling it to leeward until it meets with some obstacle which stops it, and occasions an accumulation and consequent *stream* of current. It matters not whether the obstacle be *land* or *banks,* or a *stream of current* already formed. The drift current is generally shallow, and at a mean, perhaps, of no more than half a mile an hour, when the wind is constant and a good breeze. Such a current, from a predominance of westerly winds, occupies the northern region of the Atlantic, from the N.W. and West to the E.N.E. and S.E.; and such, likewise, is the central portion of the ocean under the influence of the trade wind.

The *Stream Current* is formed by the accumulated waters of a *drift current.* It is more limited, but it may be of any bulk, or depth, or velocity. Of such is the temporary stream setting at times from the Bay of Biscay to the West of Ireland; and of such is the *Florida* or *Gulf Stream,* setting from the Mexican Sea to the Banks of Newfoundland, and terminating to the West of the Azores.

In some parts the current is compounded of *drift* and *stream;* for a *stream,* already formed, may pass through the region of a prevalent wind, in a direction according with that of its drift current, and receive an acceleration of motion from it accordingly. Of such are the Equatorial currents, which will be presently noticed.

(174.) The illustrative chart at the commencement of this section, page 313, will best explain the general current system of the North Atlantic. Although this gives the mean of all observations throughout the year, and therefore would require considerable modification in various parts, if it was made to show what is to be expected at any special time or season, yet it will correctly represent that circulatory system which is found to be common to all oceans.

Around a central area, crossed by the parallel of 30° N. latitude, and termed the Sargasso Sea, the whole of the water between lats. 10° N. and 42° or 43° N., limits varying with the seasons, revolves against the apparent course of the sun. To the North of this a portion of the water is deflected to the N.E., and, as it is presumed, after circulating around the Arctic basin re-enters the area on the West. As the meteorological equator, or the division between the phenomena of the northern and southern hemispheres lies to the *North* of the terrestrial equator we find that a reverse current, of varying magnitude and force runs from West to East on this division or from 2° or 3° to 8° N. across the whole breadth of the ocean and along the African coast, while to the South of it the westerly current of the South Atlantic runs strongly across the ocean and along the northern face of the

South American continent, a portion thus entering the northern circulatory system.

There is then some difficulty in assigning a separate designation for each part of what is almost a continuous stream, and in former times when the subject was much less understood, some inappropriate terms were applied to various portions and have become recognised and followed throughout. For the present, therefore, we are compelled to use a somewhat confused nomenclature, but it will be sufficiently explanatory till a general revision of the science may impose a new terminology.

As, has been before stated, the charts drawn up by Mr. R. Strachan for the Meteorological Office will be considered as the ground work of this section, but with some modifications of the nomenclature used.*

(174.) Of the currents and regions of the Atlantic, the first in order, from the Land's End of England, is *Rennell's Current*, a temporary but extensive stream, which sets at times from the Bay of Biscay to the westward and N.W., athwart the entrance of the English and St. George's Channels, and to the westward of Cape Clear.

Second.—The Easterly and S.E. Currents to the coasts of Europe and Africa, and southerly to the Coast of Guinea, where it may be termed the *North African Current*, flowing to the westward of South and merging into the westerly drift.†

Third.—The *Guinea Current*, an *Easterly* stream across the Atlantic between 5° and 8° N., and continuing along the coast of Africa, into the Bights of Benin and Biafra.‡

Fourth.—The *Sargasso Sea* or central area, between the Azores, Canaries, and Bermudas, &c., in which it seems that there is no particular or very various and slight currents, and is covered with the well-known Sargasso or Gulf Weed.

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* The discussion and integration of current observations involve a great amount of tedious labour, and in the works drawn up previous to that above referred to, there is no question but that the data used by Rennell and others required much revision, as each succeeding and better estimate gives a lower rate of progress to the movement of the surface waters, though previous discussions as to their nature have been confirmed. In the remarks on the Board of Trade monthly current charts, Mr. R. H. Scott, the Director of the Meteorological Department, says:—To this summary it may be added that the number of observations employed in the construction of the General Chart exceeded 7,500, each of which took 24 hours to make, so that some idea may be formed of the length of time required to accumulate them, and the great difficulty which is experienced in collecting information about currents.

† This southern set along the coast of Portugal and N.W. Africa is a faint converse of the Gulf Stream on the opposite side of the circulatory system. The northern portion of it was termed by Rennell the *North Atlantic Current*, as trending from the termination of the Gulf Stream to the coasts of Europe, &c. (Investigation, &c., p. 53.) In the Meteorological Office Work, 1872, it is called the North African Current. For the present the name which has been applied in former editions of this work is provisionally retained.

‡ Since it has been established that this Guinea Current has a different origin and character to that assigned it by Rennell and others, who argued that it was a continuation of number two, the term in some degree is a misnomer. It is an Equatorial *Counter* Current which is found in some seasons to run across all oceans. This origin was first intimated by the author in 1853.

Fifth.—The *North and South Equatorial Currents*, the vast streams caused by the Trade winds. That of the N.E. Trade running from between the tropic and Cape Verde, on the eastern side, towards the Carribbee Islands having a general westward tendency, and that from the S.E. Trade, which is usually found to the N. of the Equator, passing strongly to the westward, South of the counter or easterly current, number three above, and then strongly to the W.N.W. along the Colombian coast, joining the N.E. Trade current in the Carribbean sea.

Sixth.—The *Currents* of the *Colombian* or *Caribbean Sea*, and the *Mexican Stream*, a continuation of the Great Equatorial Streams into the Mexican Sea, from the south-eastward and eastward.

Seventh.—The *Florida* or *Gulf Stream*, an outset from the Mexican Sea, setting thence to the north-eastward, through the Strait of Florida, and thence eastward toward the Newfoundland Banks, &c.

Eighth.—The *North East Drift* which passes over the eastern side of the Atlantic, from the area East and South of the Newfoundland Banks towards and past the North West Coast of Europe and into the Arctic Basin.

Ninth.—The *Arctic* or *Labrador Current*, passing southwards from Davis Strait down the coast of Labrador, round Newfoundland, and thence south-westward past Nova Scotia and the coast of the United States inside the Gulf Stream.

In explaining this subject, we shall endeavour, in the first place to establish the facts which prove the existence of these currents, and then attempt to deduce the causes, according to the given description.

1.—RENNELL'S CURRENT.

(175.) This current, which is occasionally of considerable breadth and strength, frequently sets athwart the entrance of the channel to the N.W. and W.N.W. at some distance to the westward of the Isles of Ushant and Scilly. As it apparently depends on temporary circumstances, it is considered as a temporary stream; and, although a certain quantity of northerly indraught is always to be allowed for, with the tide of flood, on approaching the Scilly Islands, the current, unless with particular winds on the ocean, will be scarcely, if at all, perceptible.

The general causes of currents, so far as they depend upon the state of the winds, &c., are generally known to seamen; and that a long-continued wind, in one particular direction, will either produce a stream where no obstruction exists, or cause an accumulation of the water against an opposing coast, until a reverberation takes place, needs no demonstration. The latter appears to be the case in the present instance. A long and continual prevalence of westerly and south-westerly winds, in combination with a current that commonly sets into the southern parts of the Bay of Biscay, occasions an accumulation of water in the Bay, which seeks an escape, by

setting to the N.W. or W.N.W., within the limits described by half-arrows in the accompanying chart.

It would be very difficult to understand how that the great preponderance of winds from the westward of North and South, which prevail in the latitudes of Cape Finisterre, should not have some effect in forcing the water toward the coast; and, if so, what can become of it, unless it forms some current, which we should very naturally expect to find would follow the trend of the coast against which it is propelled.

That such a current does actually prevail is too well known to be doubted. Mr. Kelly, the author of a treatise on Navigation, in two volumes, published in 1733, has given a particular instance of it (Vol. i. p. 434);* by which he shows that a ship becalmed with her sails furled for forty-eight hours, was in that time carried by the current 46 miles to the northward; and we have many subsequent examples of vessels which have been set, by the course of the stream, to the northward, or upon the rocks, of Scilly. But the writer to whom we are more particularly indebted for an elucidation of the subject, is the late Major RENNELL,* who has given an illustration of it,

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* From the name of this gentleman, the current is now generally denominated RENNELL'S CURRENT.

The currents of the ocean appear to have attracted the attention of Major Rennell at an early period, and they continued to occupy the attention until the last ebb of this honourable life. The results have appeared before the world in five large charts, with a descriptive volume, dedicated to his late Majesty, William the Fourth, under the editorship of Mr. Jno. Purdy, the original author of this volume.

The Major's first Chart and Remarks on the Agulhas or South African Current appeared in the year 1778, and the important tract on the Scilly or 'thwart Channel Current, in the year 1793. In the meantime, and subsequently, some cursory remarks on the same subject were introduced in the "Illustration of the Geography of Herodotus," the Philosophical Journals, &c. In or about the year 1810, on the suggestion of a friend (Mr. Purdy), who expressed a wish to see all his writings on this subject combined and republished, he commenced his *Current Charts of the Atlantic Ocean*, and collected from the journals of his numerous friends a gleaning of information which, at length, from repeated accumulations, presented a most beautiful and singular instance of successful perseverance, on a subject never before attempted upon a plan so comprehensive. To an ordinary mind such a topic would have been regarded as dull, uninviting, and *impracticable;* by the author it was appreciated according to its importance and usefulness to mankind, and he treated it accordingly. He had long lamented the general ignorance prevalent on this subject, and which had, from time to time, produced so much loss of life and treasure, especially in relation to his native country. It is true that, in later times, practice and experience have taught the mariner, in many cases, how to shape his course to the best advantage; but still he was deficient in *theory*, and knew not the *rationale*, the *why and wherefore*, of the courses which he adopted, and the variations which might be most advantageously made in his outward or homeward passages, according to the fluctuations of season and circumstances. Such knowledge is now, in a great measure, supplied.

Among the names of the contributors to the work on the currents, that of *General Edward Sabine* is conspicuous; and were any apology required for the undertaking, his words might be quoted with propriety. In the year 1825, this gentleman published his *Account of Experiments to determine the Figure of the Earth by means of a Pendulum vibrating seconds in different Latitudes, as well as on various Subjects of Philosophical Enquiry;* and in the following terms,

"On a general review of the currents particularized on the *Pheasant's* progress (in 1822)

which places it beyond all controversy; and from whose paper, published in the "Philosophical Transactions, of the year 1793, we extract the following observations:—

"In crossing the eastern part of the Atlantic, the *Hector*, East India ship, Captain Williams, in 1788, encountered between the parallels of 42° and 49°, very strong westerly gales; but particularly between the 16th and 24th of January, when, at intervals, it blew with uncommon violence. It varied two or more points, both to the North and S.W., but blew longest from the northern point; and extended, as subsequently appeared, from the coast of Nova Scotia to that of Spain.

"Within 60 or 70 leagues of the meridian of Scilly, on the 30th of January, between the parallels of 49° and 50°, the effect of the current was first experienced, which set the ship to the North of her intended parallel, by nearly half a degree, in the interval between two observations of latitude; namely, in two days. The wind, ever afterward, prevented the ship from regaining the parallel; for although the northern set was trifling, from the 31st until she arrived near Scilly, yet the wind, being scant and light, never enabled her to overcome the tendency of the current. It is also to be observed that the direction of the current was much more westerly than northerly; the ship crossed it on so very oblique a course as to be in it a long time, and was driven, as it appears, nearly 30 leagues to the West by it; having soundings in 73 fathoms, in the latitude of Scilly, and afterwards ran 150 miles by the log, directly East, before she reached the length of the islands; running, in effect, 120 miles, and shallowed the water only 9 fathoms.

"The current was not only sensible by the observations of latitude, but by ripplings on the surface of the water, and by the direction of the lead line. In consequence of all, the ship was driven to the North of Scilly, and barely able to lay a course through the passage between those islands and the Land's End.

"There being no timekeeper on board, the longitude was uncertain; but it was concluded that the current, at times, extends to 60 leagues West of Scilly, and runs close to the West of the islands. The breadth of the stream, where the *Hector* crossed over it, was supposed to be about 30 leagues.

"A journal of the *Atlas*, East India ship, Captain Cooper, furnishes much clearer proofs, both of the existence of the current, and the rate of its motion. This ship, outward bound, in January, 1857, had advanced 55 leagues to the westward of Ushant, when violent gales began at South, and for four days continued between that point and West by South; during which time the ship was lying-to, with her head N.W. On the 5th day

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in her voyage, commencing at Sierra Leone and terminating at New York, it was found that she was indebted to their aid, on the balance of the whole account, and in the direction of her course from port to port, not less than *sixteen hundred geographical miles*, the whole distance being nine thousand, affording a very striking exemplification of the importance of a correct knowledge of the currents of the ocean to persons engaged in its navigation; and consequently of the value of the information in the acquisition and arrangement of which Major Rennell passed the latter years of his most useful life."

the wind abated, but was S.W.; stormy weather then ensued for nine days, the wind blowing from all points between South and S.S.W., but chiefly, and most violently, from W.S.W. and S.W.; and when the ship then proceeded southward on her voyage, she was, by the reckoning, only 2¼ degrees of longitude West of Cape Finisterre; but, by timekeepers, more than four degrees and a half.

"On the day the gale commenced, the reckoning was within fourteen minutes of that by the timekeepers; the latter being more westerly, owing to the current. On the third day after, the difference was about twenty-four minutes, when the ship was 25 leagues S.W. from Scilly, in soundings of 76 fathoms. The ship, in longitude 8° 28′, had entered into the stream; and, its course being opposite to that of the *Hector*, it facilitated her progress, and carried her clear of the S.W. coast of Ireland.

"After this, in the course of fifty-one hours, the ship had set two whole degrees to the westward of her reckoning; and in the forty-five hours following, she had a further set of twenty-three minutes; so that, in four days only, she had been carried by the current no less than 2 degrees and 23 minutes; and, since the gale began, 2° 32′ of long., or 93 nautic miles.

"It consequently appears, that the *Atlas* experienced a westerly current, from about 24 leagues W.S.W. of Scilly, to near 4 degrees of longitude West of the meridian of Cape Clear, where its effect was imperceptible. It may, therefore, be inferred, that the stream goes off to the N.W. in the parallel of 51°; between long. 14° and 15°, and the S.W. coast of Ireland.

"No northern set is indicated in the journal of the *Atlas*. This would have been remarkable, had the weather permitted nice attention to the reckoning; but it is to be remarked, that observations on the latitude were not regularly made; and besides, that the great distance of 36 miles was allowed for only twenty hours' drift to the N.W., when the ship was lying-to.

"From the nature of this current it must be obvious that its velocity will always be proportionate with the strength and direction of the wind, by which its direction will always be regulated, and that the middle of the stream will preserve its original course in a greater degrees than its borders. The direction of this appears to be N.W. by W., the eastern border more North; and the western more West; so that the northern current is stronger close to the West of Scilly than more to the westward.

"From the foregoing observations may be deduced the following inferences:—

"1st. That ships, which cross the current obliquely, steering a true E. by S. course or more southerly, will continue longer in it, and be more affected by it, than those which steer more directly across it. In crossing it with light winds the effect will be the same. Allowance must be made for the more northerly direction of the eastern edge of the current.

"2nd. That, after the continuance of westerly gales, even should a good observation of latitude be made, it would be imprudent to run eastward from the Atlantic during a long night. For a ship might remain in the current so long as to be drifted from a parallel, deemed a very safe one, to that of the Rocks of Scilly. It is, therefore, recommended that vessels, at such times, should keep, at the highest, 48° 45′ because in 49° 30′ the whole

effect of the currents may be experienced in the worst situation. But from the current in 48° 45′, a southerly wind will set the ship into the channel. Coming from the Atlantic, it would be still better to make Ushant.

" 3rd. That ships, bound to the westward from the channel, with a south-westerly wind, so that it may appear indifferent which tack they go on, should prefer the *port* tack, as they will then have the benefit of the current."

(176.) In a Supplementary Paper on the effects of westerly winds in raising the level of the English Channel, dated 22nd June, 1809, Major Rennel has stated:—

" In the observations on a current that often prevails to the westward of Scilly, which I had the honour to lay before the Royal Society many years ago, I slightly mentioned, as connected with the same subject, the effects of strong westerly winds, in *raising* the level of the British Channel, and the escape of the superincumbent waters, through the Strait of Dover, into the *then* lower level of the North Sea.

" The fact of the high level of the channel, during strong winds between the West and S.W., cannot be doubted; because the increased height of the tides in the southern ports, at such times, is obvious to every discerning eye. Indeed, the form of the upper part of the channel, in particular, is such as to receive and retain, for a time, the principal part of the water forced in, as may be seen by the chart; and as a part of this water is continually escaping by the Strait of Dover, it will produce a current, which must greatly disturb the reckonings of such ships as navigate the strait, when thick weather prevents the land, or the lights of the Forelands and the North Goodwin, from being seen.

" There is another circumstance to be taken into the account, which is that the *shore of Boulogne*, presenting a direct obstacle to the water impelled by the westerly winds, will occasion a higher level of the sea there than elsewhere; and, of course, a stronger line of the current toward the Goodwin.

" It must, therefore, be inferred, that a ship passing the Strait of Dover, at the back of the Goodwin Sands, during the prevalence of strong West or S.W. winds, will be carried many miles to the northward of her reckoning; and, if compelled to depend on it, may be subject to great hazard from the Goodwin.

" It will be understood, of course, that although the stream of current alone has been considered here (in order to simplify the subject), yet that, in the application of these remarks, the regular tides must also be taken into the account. But from from my ignorance of their detail, I can say no more than that I conceive the great body of the tide from the channel must be subject to much the same laws as the current itself. The opposite tide will, doubtless, occasion various inflections of the current, as it blends itself with it—or may absolutely suspend it; and the subject can never be perfectly understood without a particular attention to the velocity and direction of the tides in moderate weather, to serve as a good ground work."

(177.) After the publication of the first paper on the current of the channel, and the supplementary paper immediately preceding, Major Rennell published some further important observations upon it, which were read

before the Royal Society, April 13, 1813, and from which we have the following extracts:—

"During the interval of twenty-one years, since the Society did me the honour to receive my *Observations on the Currents to the Westward of Scilly*, more facts relating to that current have been collected, as well as observations on its effects, in different parts of its course, between Cape Finisterre and Scilly, the whole tending to confirmation of the general system set forth in 1793; and, in one instance, affording perhaps a clearer proof of the strength of the stream, in respect to its *northerly* direction, than any of those adduced on the former occasion.

"In pursuing the detail of these facts and observations, I shall begin in the neighbourhood of Cape Finisterre, and proceed with the course of the current along the Bay of Biscay; and thence across the mouth of the English Channel to Scilly, and the entrance of St. George's Channel.

"The first three facts (not detailed here) regard the current from the open sea, setting into the South side of the Bay of Biscay, and along the North coast of Spain; which current has been supposed in the former paper to be occasioned by the prevalent westerly winds, which force the water near the shore *into the bay*, and along the southern coast of it. The water so displaced would be followed, of course, by the adjacent water *behind* it, in the open sea; and so on successively, to a certain extent. The cause must surely be referred to as the origin of the Scilly current. The three facts converge, as it were, to one point; that is, in the proof that the waters of the Atlantic flow into the Bay of Biscay, along the North coast of Spain.

"It would seem that the north-westerly current, by Scilly did not, at least in many cases, balance the easterly current round Cape Ortegal and the land of Finisterre.* The loss of his Majesty's frigate *Apollo*, with most of her convoy, may surely be attributed to the operation of this current. Captain (afterwards Commissioner) Wallace assured me, that after having made, as he supposed, ample allowance for clearing Finisterre, yet, in the night, he had a very narrow escape from shipwreck. Very many others have been brought into the same kind of danger; so that the land of Finisterre, were it not discernible at a considerable distance, and its offing clear of rocks and shallows, and, moreover, situated in a finer climate, would prove a kind of Scilly to mariners.

"I have not been able to obtain any proofs on record concerning the course of the current *round* the Bay of Biscay. I formerly collected some information from a French commander respecting it. He said that the setting of the current along the coast of France, to the North and N.W., was a fact well understood, and even acted on, by many in the choice of the *tack*, on which the current gave the greatest advantage with dead winds.

"One circumstance, and that a very striking one, in respect to this particular, is, that the soundings in the Bay of Biscay show little or no *muddy*

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* Nor, admitting an equal rate in both places, could it well be. For the current enters the Bay of Biscay in an *East* direction, but goes off from it *N.W.*; so that, if a ship was carried 50 miles to the N.W. from Ushant, she would only have made about 35 westing; but, in the other case, she would be carried the *whole* 50 eastward, toward the Bay and Cape *Finisterre*.

bottom to the *southward* of the *Gironde River*, but everywhere to the *northward*. This seems to show that the mud of the *Gironde*, *Charente*, *Loire*, &c., &c., is all carried to the northward; and by what cause but a northerly current? Had the motion of the sea been variable, the mud would surely have been destributed to the South, as well as to the North, of the mouth of the Gironde. The alluvial *embouchures* of the rivers in general here, and the positions of the banks formed be them in the sea, point to the N. or N.W.; apparently the effect of the same sea-current.*

Major Rennell continues these remarks at this time, so as to include the English and St. George's Channels; but, as the navigation, set, and duration of the tides are much better understood now than when they were written, we omit them for the future. Sufficient has been said on this, the first independent current of the Atlantic which was commented on.

EXPERIMENTS ON THE CURRENT.

(178.) *Inset into the Bay of Biscay.*—A bottle from the *Lady Louisa*, bound to St. Michael's in lat. 45°, long. 13° 45', 2nd February, 1830, found on the coast of Lit, in the province of Bayonne, 14th October, in the same year.

Channel Soundings into the Bay.—Bottle from the brig *Hope*, from Havannah, 31st March, 1838, in lat. 50° 10', long. 9° 43'; wind *strong from the eastward* for three days; found on the 1st of June, 1838, on the coast of Rochefort; having probably been first impelled to the S.W. by the ebb tide and prevalent wind, and thence following the general inset to the South and East.

Query.—"Why should the sea be higher, or more dangerous, in the Bay of Biscay than it is in the middle of the Atlantic or elsewhere? Is it really so? are questions often asked.

"I believe that there is a shorter, higher, and consequently worse sea, in and near the Bay of Biscay, than is often found in other places, and attribute it to the effect of immense Atlantic waves rolling into a deep bight, where they close upon each other, and receive vibratory undulations from each shore; augmented, perhaps, by the peculiar formation of the bottom of that bay, the variation in depth, and the effects of currents, which, when running over uneven ground, or against the wind, alone cause a heavy swell—a striking exemplification of which may be seen on the bank of Agulhas, near the Cape of Good Hope."—*Capt. FitzRoy*, vol. ii., p. 45.

From Channel Soundings to the West of Scotland.—A bottle thrown from the ship *Duke of Marlborough*, Capt. Jeffery, by Mr. George Thom, near the Sole Bank, in lat. 43° 38', long. 9° W.; found on the shore of Carsaig, near the middle of the South side of the Island Mull, 14th April, 1821, and made known by Mr. Hector Maclean. At the time this bottle was thrown into the sea, the ship was on its passage to London from the Cape of Good Hope, and an allowance was made for current to the

* From a view of the Chart of Soundings between Spain and Ireland, one might be led to suppose that the deep water and steep shore along the North coast of Spain had been *partly* occasioned by the water driven in from the Atlantic, in westerly storms, along that coast; and which had gradually worn away the matter *there*, and deposited it on the bank which extends from Bayonne to the westward of Ireland. For the bank seems to expand, as it goes northward, in like manner as the current; and the water is shallower than might be expected, in proportion to the depths further in.

N.W. of 12 miles to the twenty-four hours. From the spot in which it was dropped, it seems unquestionable that the bottle was carried by the current to the West and North of Ireland, and thence between Islay and Mull, to the place in which it was found. It has, therefore, well answered Mr. Thom's purpose of *confirming Rennel's Current.*

Bay of Biscay to the North of Scotland.—A bottle, enclosing a song composed on board, from the *Great Western* steamer, on her voyage to New York, at midnight of September 10, 1838, in lat. 48° 3′ N., long. 9° 52′ W.; picked up by Captain Thornton, of the *Ceres*, in passing through the Pentland Firth, on the 16th of the same month. It must, therefore, have drifted to the north-westward and northward, off the western coast of Ireland, and thence to the N.E. and East, by the general drift from the Greenland Seas.

St. George's Channel,—A bottle from the ship *Osprey*, of Glasgow, Alexander M'Gill, master, which sailed from Greenock. This bottle (No. 310) was thrown into the sea 1st March, 1822, on the ship's return from Calcutta, in lat. 49° 54′ N., and long. 12° 30′ W. It was found on the shore, upon the South side of Milford Haven, on the 6th of the following month, April.

Easterly Current to Bristol Channel.—A bottle from the brig *Albert*, R. L. Robertson, master, lat. 47° 20′ N., long. 22° W., 24th January, 1822, on the passage from Virginia to England, the wind then about W.N.W., and had so prevailed for two or three days. Found in Rockham Bay, about 4 miles West from Ilfracombe, 29th July 1822, and attested by the agents to Lloyd's.

Bay of Biscay, North Side.—A bottle from the ship *Graham Moore*, 6th of July, 1821, in lat. 47° 47′ N., long. 7° 51′ W.; found, 15th of September, 1821, on the coast of St. Jean de Mont, arrondissement of Sables d'Olonne, department of La Vendée; and made known by the *Journal de Paris*. This bottle was impelled in an E.S.E. direction, the *north-westerly* current not then prevailing, and was within the influence of the *tide*.

By Captain Livingston's Journal, 28th of November, 1820, "It appears that in 24 hours, ending at noon of yesterday (on the passage from Gibraltar), we made about 15 miles *North* by current; and in 24 hours, ending at noon this day, about 13 North, and in the two days rather more than 20′ E. Therefore about N. 40½′ E. 37 miles in the 48 hours."

Inset to, and Outset from, the Bay of Biscay.—A bottle from the *Iris*, Captain Skinner, in lat. 47°, long. 21°, 9th September, 1802; found at the Isle of Skye (lat. 57° 15′, long. 6° 20′), 22nd February, 1803. (Probably carried into the bay on an eastern direction, subsequently northward by Rennel's Current, and thence by the eastern drift to Scotland.)

The ship *Jessie*, Bevan, master, left London for the Bahamas, about the 13th of November, 1833. She was struck by lightning and abandoned by her crew. in lat. 45° long. 15°, and on the 5th February, 1834, drove on the *Isle Groix*. near L'Orient and was immediately dashed to pieces.

Inset; Bay of Biscay.—A bottle from the *Carshalton Park*, Lieut. J. Steele Park, 27th July, 1827, in lat. 48° 39′ long. 10° 21′; taken up, 21st December, 1827, on the shore of Pembron Road, near the Loire, in the Bay of Biscay, lat. 47° 19′, long. 2° 30′ W.

A bottle from H.M.S. *Arrow*, in lat. 48° 30′, long. 9° 25, 14th July, 1838; wind from S.W. for five days, a fresh gale, and then S.W. Another bottle from the *Maitland*, transport, in lat. 49° 5′, long. 18° 19′, 10th of March, 1838. Both found, on the 25th of February, 1839, on the shore of Arcachon, in the bay, lat. about 44° 40° N.

A metal cylinder, cast from H.M.S. *Chanticleer*, Capt. H. T. Austin, 3rd of May, 1831, in lat. 44° 38½′, long. 11° 4′ W.; found near Vivero, on the North coast of

Spain, 12th of September following, at about 150 miles from the spot where it was dropped into the sea.

A bottle from the bark *Mary*, of London, Abyah Locke, master, 12th of April, 1832, in lat. 48° 30′ long. 16° 56′; found on the coast of Jart, lat. 36° 25′ 4th March, 1833.

Another bottle from the same vessel, 1st April, 1832, in lat. 46° 15′ long. 17° 58′; found near Cape Ferret, 44° 38′ 21st February, 1833.

A bottle thrown over from the *Wellington*, August 23rd, 1837, in lat. 45° 10′ N., long. 12° 58′ W.; thrown on the South coast of the Isle of Ré, probably about the end of February, 1838; found March 2nd, 1838.

Tide Water on Soundings.—A bottle from the bark *Wallace*, of Alloa, bound to Van Dieman's Land, 12th of April, 1835, in lat. 52° 13′, long. 15° Picked up at 5 miles from Ushant, 21st of August, 1835.

A bottle from the *Kent*, troop ship, in lat. 50° 20′, long. 19° 0′ W, August 19th, 1836. Picked up near Cape Blanenez, a few miles from Boulogne, December 20th, in the same year.

Bay of Biscay, South Side.—A bottle from the schooner, *Morning Star*, of Liverpool, Capt. Andrew Livingston, 7th of October, 1821, lat. 42° 45′ 39″ N., long. 13° 3′ 21″ W. Found about 22 miles to the northward of Bayonne, in the arrondissement de Dux, lat. 43° 58′ N., long. 1° 20′ W., and made known by the direction of the Minister of Marine and Colonies of France in the *Moniteur* of January 24, 1822.

One of the most singular routes of the kind that we have met with was a bottle covered with barnacles, picked up at the Mizen Head, on the S.W. of Ireland, Oct. 19, 1837. Its enclosed note stated that it was dropped off Cape Hoon, from the *Salem*, R. Crukers, master, of the United States, in lat. 53° 3′ S., and long. 67° 5′ W., on the 24th of June, 1830.

(179.) The daily rate of the inset into the Bay of Biscay, as estimated from the drift of the bottles quoted in Captain Becher's Chart (131), is as follows:—The numbers refer to Bottle Chart in the Nautical Magazine for November, 1852—No. 2 (drifted 250 miles, 4·8 miles per day; No. 3 (230 m.) 3·3 m.; No. 3*a* (270 m.), 4·5 m.; No. 5 (420 m.), 1·8 m.; No. 11 (150 m.), 0·7 m.; No. 11*a* (100 m.), 3 m. No. 16 (200 m.), 1·2 m.; No. 28 (700 m.), 4·5 m.; No. 28*a* (700 m.), 2·2 m.; No. 33 (650 m.), 4·1 m.; No. 37*a* (680 m.), 2 m.; No. 40 (980 m.), 3·1 m. It will be seen that the longest courses have the quickest rates, so that we may suppose that when the bottles become entangled in the shore tides and devious drifts, they do not travel so fast in direct distance. The mean rate of all these bottles is 3.26 miles per day. The rate at which those travel up the English Channel is very much greater, averaging 11 to 14 miles per day.

The foregoing are the principal arguments and facts upon which the existence of the thwart-channel current is inferred. That there is some cause for the drifting of the various vessels, &c., in a northward and westward direction, there can be no doubt; nor can there be any doubt that the stream varies both in strength and in direction. Without enquiring into the sufficiency of the cause to produce these effects, or of the correctness of the views promulgated by Major Rennel, the foregoing remarks have been repeated, as originally given; and here we would add, that they were formed long before any correct knowledge of the tides or of the tidal currents was acquired, and also that a very just estimate of the amount of de-

rangement of the *regular tides*, or of the set of the current across the mouths of the English and St. George's Channels, is formed from his dissertations. The remarkable revolution of the tidal streams at the entrance of the English Channel, caused by the cross action of that wave proceeding up the English Channel with that of the wave coming northward, has been well developed in the observations discussed by Adm. Beechy, as stated on p. 304.

2.—THE EASTERLY AND S.E. DRIFT-CURRENTS TO THE COASTS OF EUROPE AND AFRICA.

(180.) The currents on the shores of the Atlantic seem to have different tendencies to the South and North of the English Channel. They are certainly very devious and uncertain; but along the West Coast of Ireland and Scotland, as well as on the offing, the general set is to the *northward*. Off the southern part of the Bay of Biscay there is a well-marked current to the S.E. and *southward*, not only during those periods when the westerly winds have been prevalent, and causing the Rennell's Current, last described, but it appears to be constantly met with; and therefore, in sailing southward from British ports, this tendency of the waters should be carefully considered, especially when the shores are neared, for there they run strongest.

(181.) As stated hereafter, this well-marked current was considered to be a portion of a stream, which, running to the southward and eastward along the African coast to the Bight of Biafra, was the head of the Guinea current. But in a discussion on the general system of Ocean Currents,* it was shown to be exactly analagous to an equatorial counter current, setting from East to West, between lats. 5° and 8° or 10° North, across the entire breadth of the Pacific Ocean. In an examination of the then existing data, it was found that this well-known Guinea Current was but an extension of this *counter* current, which might then be traced nearly over to the American Coast.

In the much more extensive series of current observations collected in the Meteorological Department of the Board of Trade, and arranged by Mr. R. Strachan, the character of this current is fully established in accordance with the views expressed in 1853. As the charts contained in that work † embrace a much wider range of observation than was before attainable, we shall quote on this current, as on the other branches of the subject, the general remarks which have been based on the results obtained for each month.

(182.) By a careful calculation of the currents experienced by the ships cited in Maury's and Rennell's Charts' they appear to set with great regularity, and constantly to the south-eastward. The experience of eighty-two ships for the year gives a mean direction and rate of 9·1 miles per day to

* On Oceanic Currents, &c., by A. G. Findlay, in Journal of Royal Geographical Society, vol. xxiii., 1853, pp. 222, 233, &c.

† Currents and Surface Temperature of the North Atlantic Ocean, fram the Equator to lat.. 40° N., for each Month of the Year. 1872.

E. 34° S. for the offing of 350 miles off Cape Finisterre and the northern part of Portugal. The average of the months is greater than this:—January, 9·4 miles to S. 40° E.; February, March, April, 11, 15·9, 12·8 miles per day to E. 24° S.; May, July, 12·8, 10· miles per day S. 25° E.; August, October, November, 20·2, 10·5, 16·7 miles per day to S.S.E. These, compared with the drift of bottles, show that the latter must be affected by surface causes, as their rate of travelling is much less.* All these observations are integrated on the Chart of the North Atlantic referred to previously.

(183.) We now give the remarks drawn up by Mr. Strachan on this current in the work before quoted, first those for the annual mean, and then for each month in succession.

The North African Current.—If a line be traced from the Azores to Madeira, and thence to the African coast, in lat. 28° N. (Canary Islands), it will be seen that to the northward, as far as lat. 40° N., the average general direction of the current is to the S.E., at from 3 to 12 miles a day, the rate being strongest between longs. 10° and 15° W. Eastward of the 10th meridian the direction becomes more easterly toward the Straits of Gibraltar, but counter currents have been experienced off the coasts of Spain and Morocco. It is to be noticed that the resultant rate close to the coast of Portugal is only 1·4 miles a day, arising from the variation in direction of the observations here. South of Madeira the current, between the coast and the 20th meridian, turns to the South and then to S.S.W., down to lat. 10° N., its rates ranging from 3 to 13 miles per day. Between the meridians of 10° and 20° W., and the parallels of 30° and 10° N., this current appears to slough off to the S.S.W., S.W., W.S.W., and finally merges with the westerly drift of the North equatorial current about the meridian of 20° W., the rate being about 6 to 9 miles a day. On the whole it does not appear that the waters of the North African current mingle to a great extent with those of the Guinea Current. On the contrary, it would seem that they are finally forced towards the West by the superior strength of the Guinea Current. Even the portion of the current which passes eastward of the Cape Verde Islands does not appear in general to mingle with the Guinea Current. The general tendency northward which the Guinea Current exhibits off Sierra Leone must lead rather to the inference that some of the water of this current finds its way into the westerly drift (North Equatorial Current), mingling with the receding North African Current about latitude 10° N. Off the African coast, from 10° to 17° N., the current is a variable one, at times setting to the northward, fed by the Guinea Current, but more frequently to the southward, fed by the North African Current. Here, therefore, the general rate comes out low, being from 3 to 6 miles, though the seasonal rates are much higher. Among the Cape Verde Islands the rate is also extremely trifling, and this is probably accounted for by the

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* Estimating the set of the current by Captain Becher's bottle-chart, mentioned on page 313, we get the following:—Bottle No. 7 (drift 500 miles), 3·2 miles per day; No. 8, the carcase of a dead whale (220 miles), 8 miles; No. 9 (300 miles), 12 miles; No. 13 (250 miles), 4·1 miles; No. 18 (1,000 miles), 3 miles; No. 136 (550 miles), 5·5 miles per day, giving an average of nearly 6 miles per day.

effect of tides upon a ship's course near the land, as sets in various directions have been reported here.

January.—The North African Current flowing to the southward between Portugal and long. 18° W., acquires an easterly tendency towards the Mediterranean Sea. After passing the Madeira Islands it flows to the westward of South, extending to long. 25° W. in the latitude of the Cape Verde Islands, where it merges into the westerly drift. The portion which passes between these islands and the continent merges into the Guinea Current about lat. 10° N. The daily rate of this current is from 6 to 18 miles.

February.—The North African Current, between the parallels of 40° and 30° N., extends from the coast to long. 18° W. Here it appears to be fed by a drift from the W.N.W., which is traceable to long. 35° W., and a tendency towards the Mediterranean is apparent. The daily rate is from 9 to 22 miles. Southward, to the 20th parallel, observations are deficient, but between 20° and 10° N. the current, though very feeble, is still perceptible. Eastward of the Cape Verde Islands it tends towards the land while drifting onward to join the Guinea Current in lat. 10° N. Westward of these islands it soon becomes lost in the westerly drift. From the 20th to the 5th degrees of latitude the rate of this current varies from 8 to 19 miles per day.

March.—The North African Current does not appear to have a decided southerly set near the land as much as along the 20th meridian, where it travels 20 or 30 miles a day abreast Cape Verde. The easterly tendency towards the Mediterranean is well marked at from 7 to 20 miles per day. To the North of the Canary Islands there is evidence of a counter westerly set at the rate of 10 to 14 miles. From lat. 15° N., long. 20° W., to 5° N., 15° W., a north-westerly set has at times been experienced of 17 to 23 miles daily, considerably stronger than the south-easterly sets, which are reported there in this month. From 20° to 10° N., and 25° to 27° W., the currents appear to be uncertain, but to the westward the westerly drift seems established.

April.—The North African Current exhibits more decided southing than in March, but the inset to the Mediterranean is scarcely perceptible. It extends about 10° from the land, from lat. 40° to 8° N., where it joins the Guinea Current on the right, and the westerly drift on the left.

May.—The tendency of the current towards the Mediterranean is still evident, but the flow southward is more decided than in April. From 40° N. to the Canary Islands the rate is from 7 to 21 miles. This current extends generally about 10° from the land. South of the Canary Islands the current tends towards the West. It mingles with the Guinea Current about lat. 7° N., and with the westerly drift along the meridian of 25° W., reaching as far South as lat. 7° N. As a south-westerly current its rate is about 12 miles.

June.—The North African Current can be traced from lat. 40° to 9° N. It still sends an easterly current towards the Mediterranean, at a rate of 6 to 18 miles. Between the Canary and Cape Verde Islands its direction is south-westerly, but the stream is feeble, the rate being from 6 to 18 miles. It does not pass between the Cape Verde Islands and the coast, but lies entirely to the westward of these islands, where it soon becomes merged in the

westerly drift. Between lats. 20° and 9° N., longs. 23° and 30° W., it is stronger than elsewhere, its velocity ranging from 8 to 19 miles per day.

In *July* the current appears to be feeble and unsettled, and the indraught to the Mediterranean is barely traceable.

In *August* it does not seem that the current is well maintained, nor is there decided evidence of a set towards the Mediterranean; however, the observations in this month are deficient.

September.—The North African Current can be traced to the Cape Verde Islands, but it is feeble throughout its course. Very little tendency is apparent towards the Mediterranean; indeed, the direction of the set is sometimes opposite.

In *October* the current reaches to lat. 10° N., but it is feeble and irregular, being best defined close to the coast.

In *November* the current is stronger and more regular than in September and October. Off Portugal its set is E.S.E., and rate about 12 miles. It can be traced as far South as lat. 9° N.

In *December* the North African current has become a steady flow, and can be traced at times from lat. 40° N. to 10° N. In the region of the Cape Verde Islands it loses force, and becomes less regular.

(184.) In addition to these remarks we give, as in previous editions, the particulars of various bottles and other experiments, which are very interesting, and will be serviceable in estimates of what amount of current may be expected in this part of the voyage.

South-Easterly Current off Channel Soundings.—In August, 1826, Captain Livingston, in the *Jane*, between lat. 48° 53′, long. 16° 7′, and Cape Clear, had a set of 1° 14′ S. and 1° 54′ E. So that in four days the vessel was set, by a counter current, 74 miles S. and 65 E., or nearly S. 41° E. about 99 miles; equal to a daily average of 24¾ miles.

Toward the Bay of Biscay.—The ship *Carshalton Park*, Captain J. S. Park, on returning from Jamaica to London, in July, 1824, in lat. 48°, and long. 13°, got into a stream setting to the southward, and which thence operated so strongly against the ship, that some difficulty was found in getting sufficiently far to the northward for a good Channel track. The wind shifted suddenly from S.W. to N.; the vessel immediately hauled up E. by S.; and although the weather was fine, and the water quite smooth, she made no better than a true E. by N. course.*

Off the Coast of Portugal.—A bottle from the brig *Freeland*, Captain T. Midgley (from Liverpool to Africa), in lat. 41° 50′ N., long. 14° 23′ W., 11th of February, 1833. Picked up close to the shore, off the Harbour of Vigo, on the 1st of March following, having traversed, in a true E. ½ N. direction, about 80 leagues.

St. George's Channel to Cape St. Vincent.—On the 14th of August, 1823, Captain

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* The same ship, on the 10th of July, was on Channel soundings, the latitude by meridian altitude of the sun, 48° 53′; the longitude, by chronometer and lunar, 9° 44′ and 9° 56′, respectively, "kept the ship E. ½ S. and generally East till 11·51 p.m., when, by the moon's meridian altitude, it was found that the latitude was 49° 21′. We had gone, during this interval of 11h. 51m., 68 miles by the log, carefully attended to, in smooth water. Now, allowing 2½ points of variation, we ought to have made 26′ of northing; whereas, in point of fact, we made 13′ only."

Influenced, probably, by the Channel ebb; the current appeared also to have a tendency to the West.

Capt. Livingston, in the sloop *Favourite*, on his passage from Liverpool to Gibraltar, took his departure from the *Smalls Lighthouse*, and thence he regularly made observations on the current, &c., so far as adverse weather permitted. On the 23rd he had arrived on the parallel of 46° 23′; previously to which the course seems to have been materially affected by the tide, but here the differences amounted to 51′ 55″ southerly, and only 4′ 39″ N. From lat. 46° 23′ August 23, to lat. 36° 52′, August 31, the current invariably predominated to the southward, and between these parallels amounted to 89 miles in the eight days.

At 4h 53m of August 31, with Cape St. Vincent bearing true North, an excellent meridian altitude of the planet Saturn gave lat. 36° 52′ 8″. The total southing to this point gave 2° 18′, and the difference of longitude between dead reckoning and that by landfall gave 1° 42′ 7″ of easting.

In the brig *Friends*, of Glasgow, 24th of August, 1820, Captain Livingston states —"The current set us round Cape St. Vincent without our having seen the cape, though we steered courses for the purpose of seeing it, and we were looking out for it, when I got a lunar, and ascertained that we were then past it. Immediately after this the sea became smooth, being broken off by the cape."

Between *Cape Finisterre* and the *Azores*, the general drift of the surface of the sea appears to be to the south-eastward; varying, however, to the East and West, and even to the northward, as the winds operate, either one way or the other, more especially during winter, as already noticed.

H.M.S. *Pactolus*, in May, 1816, experienced a current South a little East, at the average rate of 30 miles a day, from the English Channel to St. Michael's.

Captain Charles Hare, in the brig *Ward*, from New Brunswick, September, 1823, with westerly winds, which had prevailed for fourteen days, between latitude 43° 40′ and 45° 20′, long. 22½° to 16°, found the current E.S.E. 1½ mile in the hour.

Between *Portugal* and the *Western Islands*.—Captain George Cheveley, June, 1830, lat. 44° to 27°, long. 11° to 21°, current S.E., three-quarters of a mile an hours.

The *Current* along the *Coast of Portugal* appears to set nearly in the direction of that coast. On the 25th of October, 1810, a gunboat for the service of Cadiz, being in tow of the *Rebuff* gun brig, broke adrift in a gale of wind, in lat. 39° 44′, and long. 9° 38′ W. On the 19th of November following, his Majesty's sloop of war *Columbine*, when cruising 8 or 9 miles to the westward of Cadiz Lighthouse, observed a gunboat to leeward, which proved to be the identical boat that twenty-five days before had broken adrift from the *Rebuff*. The distance traversed by the boat was about 350 miles, or 14 miles a day, chiefly by the current, the wind in the meantime being so various as nearly to render the drift negative, or, if anything, against the set of the current.

On the currents setting toward the Bay of Biscay and the Strait of Gibraltar, Capt. afterward Admiral, Sir Erasmus Gower made observations in five passages to Madeira, from which he concluded the most general direction to be to the S.E., and the mean velocity about 11 miles in every 50 leagues.*

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* The effect of a current setting to the south-eastward, and the necessity of a competent knowledge of currents in general, cannot any way be more forcibly shown than by noticing the melancholy catastrophe of his Majesty's ship *Apollo*, Captain J. W. T. Dixon, and the merchant ships under her convoy, on the 2nd of April, 1804. The *Apollo*, with sixty-nine ships for the West Indies, sailed from the Cove of Cork on the 26th of March. With a fair wind, blowing strong, they steered about W.S.W. until the 31st, when the wind changed more to the westward. At noon, on the 1st of April, latitude observed 49° 51′ N., longitude, by *account*, 19° 29′. At eight p.m. the wind shifted to S.W., and increased to a gale, with a heavy sea. The convoy stood to the S.S.E., and, at half-past three

In proceeding to Tenerife, Sir Erasmus Gower observed a constant current setting to the southward at the rate of a mile an hour; equal to 22 miles in the distance between Madeira and that island.

Capt. Mackintosh, of the *Hindostan*, who had made twenty passages in this route, generally experienced a current from the 39th degree of latitude to that of the Canaries. In this part of the ocean he generally found, from repeated and accurate observations, that this current sets to the E.S.E. He found it strongest opposite to the entrance into the Mediterranean or Strait of Gibraltar; and, in one voyage, the current was computed, by his chronometer, to set about 40 miles per day. This current inclines more southerly as it approaches the Canaries. It strikes on the coast of Morocco, and takes, about Cape Boiador, a different direction. Nearly in-shore, from an indefinite point, one part of the stream sets northward toward the Strait of Gibraltar, and the other parts sets to the southward.

M. le Baron le Roussin, in the corvette *Bayadère*, bound from Rochefort to Brasil, in February, 1819, after passing Cape Finisterre, found the prevailing winds from noon to noon, and currents, as follow:

	Latitude.	*Longitude.*	*Winds.*	*Currents.*
Feb. 22	42° 43′ 38′	11° 40′ 0″	N.—W.N.W.	S.S.W. 24 miles.
23	40 3 28	13 44 17	N.—N.E.	S.S.E. 12 —
24	37 3 49	13 35 30	N.E.	S.S.E. 12 —
25	34 13 11	14 13 30	N.E.—S.E.	S.E. 6 —
26	31 9 17	14 14 40	N. and N.E.	S.10°E.12 —

But on arriving at the Canaries, with the wind North and N.E., the current had changed.

On the course of the same vessel, from Brest to Brasil, in October, 1821, the current had set on the last 24 hours (October 6), lat. 40° 24′ 36″, long. 14° 29′ 30″, S. 15° E. 20 miles; on the three following days, nearly in the same direction, but with less than half the strength. In lat. 35° 20′ 50″, long. 12° 54′ 40″, 15 miles S.E. In lat. 33° 54′, long. 12° 48, it had set only 6 miles S. 5° E.; but, on the next day, in 34° 18′ 24 N., and 12° 21′ W., 25 miles S. 25° E.; and again in 34° 14′ 34″, South, 20 miles. Off the African coast, lat. 32° 56′ 20′, long. 13° 16′ 20″, it had set 32 miles to the S.W., or in a direction nearly parallel with the shore.

At about 74 leagues W. ½ S. from Cape Mondego, on the 9th of June, 1799, M. de Humboldt, in the sloop *Pizarro*, was on his voyage to the West Indies; and, on this day, in lat. 39° 50′, and long. 13° 50′, he says that they began to feel the effects of the current setting toward the Strait of Gibraltar, &c. From the parallel of 37° to that of 33°, the vessel was sometimes carried, in twenty-four hours, from 18 to 26 miles to

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next morning, struck on the coast of Portugal, in about 40° 22′ N., 3 leagues to the northward of Cape Mondego. Captain Dixon, and about sixty men of the *Apollo*, perished in their endeavours to reach the shore; the other part of the crew remained two days clinging to a fixed part of the wreck, without nourishment. About forty sail of merchantmen were wrecked about the same time; some sank with all their crews, and most of them lost several men. The lamentable event has been attributed to want of chronometric observations, and the consequent ignorance of the set of the current, which must certainly have been very strong.

"The immediate cause of the loss of so many of the *Apollo's* convoy appears to have been the blind confidence with which the commanders followed their commodore; either keeping no reckoning themselves, or believing his more accurate than their own. Several ships were saved by leaving the convoy, and it is said that the commander of a Clyde ship warned the Commodore of his danger in time to have avoided it."—*A.L.*

the eastward. The direction of the current was, at first, E. by S.; but nearer the strait it became due East, and it assumed a more southerly direction on the passage toward Tenerife. "Several pilots, who frequent the Canary Islands, have found themselves on the coast of Lanzarote, when they expected to make good their landing on Tenerife."

Don Vicente Tofino had, ten years before, proceeded in the *Lucia*, from Cadiz, for Mogodor; he sailed on the 27th of April, 1785, and on the 1st of May, before midday, arrived at the last-named port. On the 6th he sailed from it, and on the morning of the 8th anchored again in Cadiz. On his voyage out, he found that the current, in four days, had set him 21½ miles S. 18° E., and on his return S. 49° W. 39 miles. This variation of the current shows, that the waters throughout all this extent do not always run to the S.E., but that they vary, with the line of coast, to the south-westward also.

H.M.S. *Pique* was once set to the S.E., 98 miles in five days, between Cape Finisterre and Madeira. H.M.S. *Raleigh*, August, 1826, found the current from off Cape St. Mary, toward the Strait, to set W. 34° S. 26 miles in the twenty-four hours.

(185.) The following observations on the currents between the *Canary and Cape Verde Islands*, have been selected from Commander Maury's "Sailing Directions," 1859, vol. ii. The experience of all the ships whose logs are there recorded, is nearly unanimous in stating the southerly and easterly drift. Of course the vibration of the Trade winds with the seasons has much to do with the southern limit of this southerly set, as will be seen below:—

Ship *Jenny Pitts*, Capt. J. L. Snow, December 27, 1853, lat. 30° 3′ North, long. 20° 0′ W., current 8 miles S. by W.; 18th, 28° 52′ N. 18° 10′ W., 6 miles S.S.W.; 30th, 25° 26′ N., 18° 26′ W., 8 miles S. by E.; January 1, 1854, 19° 51′ N., 22° 55′ W., 8 miles S. by E.; 2nd, 16° 42′ N., 21° 23′ W., 10 miles S.; 3rd, 13° 42′ N., 22° W., 8 miles S.

Ship *Margaret Mitchell*, Captain T. Jameson, January 11, 1854, lat. 30° 16′ N., long. 17″ 35′ W., 22 miles E. by S.; 13th, 26° 7′ N., long. 20° 24′ W., S. 39° W. 14 miles; 14th, 24° 15′ N., 20° 11′ W., 12 miles E. by S.; 16th, 20° 18′ N., 20° 31′ W., 18 miles, S. ¾ W.

Ship *Romance of the Sea* (W. W. Henry), February 18, 1855, lat. 30° 10′ N., long. 18° 10° W., 1½ knot, N.E.; 19th, 29° 20′ N., 19° 0′ W., 1½ knot, N.E.; 20th, 26 0′ N., 19° 28′ W., 1 knot E.N.E.

Ship *Gloriana*, Captain Henry Toynbee, from London to Sydney, April 22, 1855, 30° 18′ N., 19° 20′ W., 12½ miles S. 5° W.; 24th, 26° 3′ N., 21″ 32′ W., 8½ miles N. 25° E.; 25th, 23° 38′ N., 22° 50′ W., 4½ miles N. 12 W.; 26th, 20° 37′ N., 24° 22′ W., 6½ miles N. 15° E.; 27th, 17° 22′ N., 26° 4′ W., 9½ miles S. 57° W.; 28th, 14° 5′ N., 26° 23′ W., 16 miles S. 60° W.; 29th, 11° 12′ N., 26° 36′ W., 20 miles S. 9° W.

Ship *Resolute* (D. McKenzie), June 17th, 1854, lat. 29° 54′ N., 21° 12′ W., 12 miles S. 60° E.; 19th, 26° 1′ N., 24° 2′ W., 12 miles, S. 13° E.; 21st, 21° 44′ N., 26° 22′ W., 12 miles W.S.W.

Ship *Orion* (H. Libbey), July 3, 1856, 29° 5′ N., 23° 30′ W., 12 miles S.

Ship *Panther* (N. G. Weeks), August 10, 1854, in lat. 28° 9′ N., 22° 30′ W., 12 miles W.S.W.; 12th, 23° 32′ N. 25° 38′ W., 15 miles W.S.W., &c. *Note.*—The ship at this time in the N.E. Trades, which have during the summer reached to the higher latitude.

Ship *Hurricane* (St. Very), August 22nd, 1855, lat. 30° 31′ N. 18° 0′ W., 12 miles S.W.; 23rd, 27 11′ N., 19° 15′ W., 8 miles S. ½ W.; 24th, 23° 50′ N., 19° 25′ W., 11 miles S. by W.; 25th, 21° N. 19½° W., 6 miles S. ½ W.; 26th, 18° 4′ N., 19° 45′ W., 7 miles S. ½ W.

Barque *Mea* (B. Buxton), August 17, 1859, lat. 25° 41′ N., 21° 14′ W., 12 miles S., 18th, 23° 16° N., 22° 54′ W., 8 miles S.

Barque *Adler* (E. Thiel), October 27, 1849, lat. 25° 17′ N., 23° 33′ W., 27 miles S. 31° W., two days; 30th, 18° 13′ N., 25° 49′ W., 13 miles S.W.; 31st, 15° 45′ N., 26° 35′ W., 12 miles S.W. ½ W. (trade wind).

Ship *Colorado* (Ricker), October 19th, 1855, lat. 31° 15′ N., 16° 49′ W., 12 miles S.E.; 20th, 28° 33′ N., 18° 47′ W., 24 miles S.S.E.; 21st, 26° 16′ N., 20° 11′ W., 12 miles S.W.; 24° 22′ N., 21° 15′ W., 6 miles S.W.

(186.) Mr. James Grey Jackson, in his valuable "Account of the Empire of Morocco,"* has stated that the coast, between the latitudes of 20 and 32 degrees North, is a desert country, interspersed with immense hills of loose sand, which are, from time to time, driven by the wind into different forms, and so impregnate the air with sand, for many miles out to sea, so as to give the atmosphere an appearance of hazy weather; navigators, not aware of the circumstance, never suspect, during such appearances, that they are near land, until they discover the breakers on the coast, which is, in some parts, so extremely flat, that a person may walk a mile into the sea without being over the knees; so that ships strike when at a considerable distance from the beach; added to this, there is a current, which sets in from the West towards Africa with inconceivable force and rapidity, with which the navigator being generally unacquainted, he loses his reckoning, and, in the course of a night, perhaps, when he expects to clear the African coast, in his passage southward, he is alarmed with the appearance of shoal water; and, before he has time to recover himself, finds his ship aground on a desert shore, where neither habitation nor human being is visible. In this state his fears are soon increased by a persuasion that he must either perish in fighting a horde of wild Arabs, or submit to become their captive; for soon after a ship strikes, some wandering Arabs, strolling from their duar in the desert, perceive the masts from the sand-hills; and, without coming to the shore, repair to their horde perhaps 30 or 40 miles off, to apprise them of the wreck, when they immediately assemble, arming themselves with daggers, guns, and cudgels. Sometimes two or three days or more elapse before they make their appearance on the coast, where they await the usual alternative of the crew either delivering themselves up, rather than perish with hunger, or throwing themselves into the sea.

(187.) The ship *Montezuma*, of Liverpool, Knubly, master, sailed on the 26th of October, 1810, from Brazil, but was wrecked on the 23rd of the next month, at three a.m., on the African coast, somewhere between Capes Noon and Bojador. Among the crew, who were taken and sold by the Arabs, was Alexander Scott, an apprentice. This person was detained in the country for nearly six years; and a very interesting account of his captivity, drawn up by Dr. Traill, with geographical observations on his routes, and remarks on the currents which produced the catastrophe, by Major Rennel, were given in the fourth volume of the "Edinburgh Philosophical Journal." As these remarks give a very clear notion of the movement of the waters, derived from observation, we repeat them as heretofore.

(188.) Major Rennell remarks on the currents between Cape Finisterre and the Canary Islands:—"I should consider myself highly culpable if I neglected to state, by way of caution to navigators, the result of my inquiries respecting the currents which appear to have caused the shipwreck of the *Montezuma*, and of a great number of other ships of our own and other

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* London, quarto, 1809. See, also, the affecting "Narrative of the Shipwreck and Captivity of M. de Brisson," in 1787; and that of Robert Adams, wrecked in the American ship *Charles*, John Horton, master, 1810. The latter is noticed more particularly, with others, in the description of the Coasts of Africa, hereafter.

nations, on the western coast of Barbary, having examined a multitude of journals of ships that have sailed in that track, with timekeepers on board, and which have also, when opportunities presented themselves, had their rate checked by celestial observations.

"The general result is, that navigators who depart from the parallel of the southern part of the Bay of Biscay (or say 45°), and sail in the usual track southward, will be assailed first by a *S.E.* current, and then by an *easterly* one, until they have passed the parallel of Cape Finisterre, when the current will again turn to the *South* of *East*, and gradually become a S.E. current, till, having passed Cape St. Vincent, it becomes easterly again, owing, no doubt, to the indraught of the Strait of Gibraltar; and this easterly current is pretty general across the mouth of the bay, between Cape St. Vincent and Cape Cantin.

"Beyond this bay (which may be termed the *funnel*, of which the strait itself is the *spout*) the current again becomes S.E., or rather more southerly (as it is more easterly toward Cape Finisterre), and continues as far as the parallel of 25°, and is, moreover, far beyond Madeira westward; that is, at least 130 leagues from the coast of Africa, beyond which a S.W. current takes place, owing, to the operation of the N.E. Trade wind.

"The rate of motion of this current varies very considerably at different times; that is, from 12 to 20 or more miles in 24 hours. I consider 16 as rather below the mean rate. I have one example of 140 miles in eight days, in one of his Majesty's ships, equal to 17½ miles per day; and, in another, of only 12. And in a very well kept East India ship's journal, 170 in nine days to Madeira, or 19 per day. The direction of the stream likewise varies, but commonly more toward the *South* than the East, after passing the mouth of the strait.

"Near the coasts of Spain and Portugal, commonly called the Wall, the current is always very much southerly, owing, perhaps, to the falling in, obliquely on the shore, of the great mass of water brought by the S.E. current; which can run off only toward the South, and round Cape St. Vincent toward the strait's mouth. And amongst the Canary Islands, and between them and the coast of Barbary, the currents are less regular.

"It may be taken for granted that the whole surface of that part of the Atlantic Ocean, from the parallel of 40° to 45° at least, and to 100 to 130 leagues off shore, is in motion toward the mouth of the Strait of Gibraltar.

"According to what has been said, in the course of the above remarks, it must be expected that a ship, sailing in the usual track to Madeira or the Canaries, will be carried to the *south-eastward*, at the rate of 16 miles per day, that is, even if she has a fair wind, she will be carried by the current 150 or 160 miles to the south-eastward, in the course of a voyage to Madeira or the Canaries; and, consequently, on a *S.E. by S.* course, will be carried 80 or 90 miles to the eastward of her intended port. If we suppose a *S.E.* course, the error in easting will be no less than 109; which distance, if they are bound to Tenerife, would carry them to Allegranza or Forteventura; and, if intending to make Allegranza, would place them on shore on the coast of Barbary. The French and Spaniards report that their ships have often made Allegranza when they supposed themselves on the line toward Tenerife. It must be added that, if a ship had a long passage, the

error would be greater in proportion, and might possibly amount to 200 miles of easting.

"It would seem advisable, therefore, that every ship going to the Canaries, or intending to sail between those islands and the main land of Africa, and being without timekeepers, as that class of merchant ships commonly are, should, to every day's reckoning, *add ten miles of easting.* This would, in the first instance, prevent them from *deceiving themselves* as they went forward; in like manner, as it is better to set a clock forward at once, than to charge one's memory continually with its being too slow. *Ten miles* does not seem too much as a cautionary measure, as a ship has very lately been carried 99 miles to the *East* in eight days in that track. What would not have been the error had she had even a moderately long passage?

"It is this current which has furnished the roving Arabs of the Desert with the victims from every nation, and the good Mr. Willshire, the English Consul at Mogodor, with objects of benevolence."—27th Feb. 1819.

The *Eliza*, commanded by John Searchwell, sailed from Cork for Rio Janeiro with settlers, on the 12th of August, 1827, and ran ashore on the coast of Africa, during a fog, on the 25th of the same month. Whilst making signals of distress, three fishing boats from Canary came to her assistance, and succeeded in saving all the lives on board, consisting of 18 mariners, 244 men, 46 women, and 42 children; in all, 350 persons, who arrived at Canary on the 3rd of September.

About the end of October, in the same year, the *Olymphe*, from Havre for Buenos Ayres, with colonists, was cast away on the same part of the African coast. The passengers, about 300 in number, consisting of French, English, Germans, and Swiss, were taken from the shore, saved from captivity by Canarian fishing-boats, and conveyed to the Grand Canary, where they were landed on the 7th of November. Such has been the effects of the current!

The preceding description of the currents between the English Channel and Canary Islands was corroborated, 1826, by Capt. R. H. Newby, in the *Napoleon* schooner, which left Dartmouth on the 21st of July, and was set to the eastward of reckoning, while crossing the Bay of Biscay, 1° 21′ of longitude in 48 hours. On Monday, the 25th of the same month, the entrance of Ribadeo bore S.W. by compass, about 15 miles, and the vessel was then in about 6° 55′ West.

The effect of the easterly current was proved by the bearings of a remarkable mountain inland, and some whitish cliffs on the shore; and Capt. Newby says, the schooner was setting to the eastward as fast as I have noticed a ship to lose ground to the eastward while standing inshore of Beachey Head during a strong flood tide and moderate westerly breeze. At about 5 p.m. the wind veered to the N.E., and even then, although the vessel was going at the rate of 3½ knots through the water, she made very little way to the westward till toward sun-down, when the breeze freshened to 7 or 8 knots. During the night passed Cape Ortegal; and the next morning, at 6 a.m., the light-tower at the entrance of Coruña bore South.

Upon going over the two day's work, July 27th and 28th, it appeared that, instead of passing, as supposed, to the westward of Madeira, the *Napoleon* was actually without a sight of the island to the *eastward;* and had

the vessel been involved in fog, or have been bound to Lanzaroto or Fuerteventura, and steering, by reckoning, a fair course for them, the consequence must have been that she must have fallen into broken water when least expected, or have grounded on the main shore, somewhat between Cape Ghir and Cape Noon, and property, if not life, would have been lost.

The following remarks on the currents on the western coast of the Spanish Peninsula, are given in the Anuario Hidrografico for 1867 :—

On the western shore of the peninsula the currents are strong, and in its immediate neighbourghood run from South to North, and North to South, according to the prevailing wind. But in the offing they incline to the N.E. or S.E., according as the wind may be S.W. or N.W. Against these on-shore winds vessels must therefore take precaution, for if the S.W. wind is blowing, or even the N.W. also, the vessel will drift to the shore. Experience has shown that allowance must be made for drift by steering more westerly courses than the lay of the coast would require to keep clear of it, especially when it is blowing hard.

It is observed on the coast of Galicia, and the same would naturally occur on the coast of Portugal, that, on one or even two days previous to a gale, the current sets towards that point of the horizon from which it will eventually come; that is, when the current sets to the South without any apparent cause the Vendaval will come in a gale, and a similar result follows when the current sets to the North. So that the fishermen who have most to do with allowing for currents know very well by them when a N.E. or S.W. wind is about to set in.

The current generally produced by the wind sets to the N.E. and North, when that is from any point between South and West, and it sets to the South when the wind is anywhere between West and East from the northward. In winter, the current sets mostly from some point between North and East, and in summer from some one between North and West; and its hourly rate is about 2 miles, and even more, with a strong Vendaval.

The navigator who finds himself off Cape Finisterre with a Vendaval to beat against, must be careful of the shore in bad weather, for he will be drifted insensibly to leeward until he has passed Cape Prior.

With respect to ships off Cape St. Vincent, bound towards Cape Finisterre with fresh N.E. winds, they will find enough to do, to overcome the current they will meet with along the coast. And with fresh N.W. or S.W. winds there is also a rise in the level of the sea, in all the estuaries and ports of the peninsula, the reverse of what takes place at Cadiz and in the Bay of Biscay with N.E. winds.

(189.) The Baron Roussin's Remarks on the Currents between Cape Bojador and the Isles de Los.

The general currents on the African coast, between Cape Bojador and the Isles de Los, with the exception of some places subject to a more or less regular tide, are uniform during the eight months which comprise the fine season. They follow exactly the trend of the coast from North to South.

From Cape Bojador to the Cay of Cyprian (lat. 22° 20′) they therefore set to

the S.S.W., from that bay to Cape Blanco; and along the whole extent of the Bank of Arguin to its western point, which is in the parallel of 20° 6′ 20″ North, they set S. by W. To the southward of this point the waters, being no longer guided by the edge of the bank, which turns abruptly to the S.E., do not follow in a body, within a certain space, any fixed or determined direction. One part of their mass experiences a number of irregular windings, until, finding itself in the active body of the general current, which left the bank at its most salient point, it rejoins it, and is carried on as before.

In the vicinity of Tanit Bay, in the parallel of 19° 10′ N., it again resumes its former direction, and follows the trend of the coast, thus setting to the southward as far as the two Palms, near Portandik, and from thence S.S.W. to the Marigot of Musquitoes. It then sets S. ½ W. till abreast of the Bar of Senegal, where in a space of 4 leagues in circumference, it is disturbed by the stream of that river. This stream is so strong as to oblige vessels at the anchorage off the bar to trend to it, in spite of the strongest winds. The current, joined by the waters of the Senegal, pursues its course along the coast, which trends to the S.W., observing a very gentle curve, which forms the Bay of Yof, and which terminates at Cape Verde. The strong currents hitherto pretended to set into the Bay of Yof are, therefore, merely chimerical, and the depth given to this bay in all the charts is no less so. Cape Verde being the most western point of Africa, and hence forming an obstruction to the general direction of the waters which flow along that coast, must occasion a great variety of currents in its vicinity. It is, in fact, what takes place, and it would, therefore, be difficult to define a particular one. This only appears certain: vessels passing in sight of Cape Verde are not carried on it, as is generally supposed; but, on the contrary, they are swept off by the prevailing tendency which the waters have to flow to seaward. In running close to the Almadie Rock, this repulsion is sensibly felt during the eight months which I have mentioned. It appears that the current rushes between the rocks, and spreads itself in different directions.

Immediately to the southward of Cape Verde the current is almost imperceptible, and it is scarcely possible to assign any particular direction to it as far as Cape Naze. The whole of the coast lying between this cape and Cape Manual forms a well defined bay, totally free from current, and in which there is not a single river. The same is observed with respect to the roadstead of Goree, although, according to the observations of Mr. Adanson, a regular tide exists there, with a rise and fall of 2 feet 6 inches. In the offing of Cape Verde the current has been always found to set to the southward. From Cape Naze it again follows the direction of the coast, interrupted only at the mouths of the principal rivers, which lie between this cape and Cape Roxo. From this point, localities of a very different nature produce particular effects in the current. The Archipelago of the Bissagos here succeeds the straight coast which extends to the northward. Large rivers empty themselves amongst these islands, forming various channels, more or less encumbered with sand-banks. These obstacles cause a variety of currents, which will be explained when treating on the Bissagos.

Strength of the General Current.—The rate of the general current on the African coast, deduced from numerous observations, has never exceeded a

mile and five-tenths per hour on the coast itself, and on the outer edge of the banks; and more frequently it has been found from seven to nine-tenths of a mile. This is diminished one-third, and frequently one-half, at a distance of 4 leagues from the coast. Should a vessel have run past her port, there is no fear of her stemming this current, and, by long boards, easily regaining her destination.

In the rainy season, which is from the commencement of June to the end of October, as the wind blows from various directions, the currents are no longer regular, and it is impossible to establish any positive law respecting them; but, even under these circumstances, their strength is not so great but that it may be surmounted.

3.—THE GUINEA CURRENT.

BEING AN EASTERLY STREAM ACROSS THE ATLANTIC, AND ALONG THE COAST OF AFRICA, INTO THE BIGHTS OF BENIN AND BIAFRA.

(189.) In the description of the winds (6), p. 175, and (64, 65), p. 222, and in the diagram illustrating the Best monthly Routes across the Equator, it is shown, that between the N.E. and S.E. trade-winds there is a belt of calms and variable winds, which, on the African coast, assume the character of monsoons, as, during the summer months especially, the wind blows more or less toward the African coast.

In the currents there appears to be an analogous system, as there is an *easterly* current flowing with considerable velocity eastward, in an opposite direction to the great equatorial drifts on either side of it. Its existence and character along the Guinea Coast has been long known. It was formerly thought to be a continuation of that current which we have just described as passing southward from Western Europe, but later investigations seem to point to the fact that it is a flowing back of the waters heaped up to the westward by the prevalent winds. In tracing the currents of the Pacific Ocean,* we find that there exists a precisely similar current in that great ocean setting into the Bay of Panama, in the same latitude. This current is traced very far to the westward—in fact, nearly across the ocean.†

(191.) Commencing with the ordinary westernmost part traversed by vessels crossing the Equator, we select from Commander Maury's Sailing Directions the following facts:—

(192.) Capt. H. T. Walter, barque *Phantom*, says:—In July, 1853, between lat. 5° and 8° N.. and about long. 36° and 38° W., the current set us fast to the eastward.

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* See Directory for the North Pacific Ocean, by A. G. Findlay, and also Journal Royal Geographical Society, vol. xxiii., 1853, pages 222, &c., as before quoted on p. 327.

† The non-continuity of this Guinea current with that which flows southward from Portugal and N.W. Africa, the North African current, was demonstrated by the author about twenty years since, and its analogy with the equatorial counter-current in the Pacific, and also with a periodical easterly current in the Indian Ocean.

Again, in August, 1854, about the same latitude and longitude, the current set is 110 miles N.N.E. in three days. Capt. Millet writes :—December 25, 1855, lat. 4° N., long. 29° W., have experienced an easterly current these last two days. I have always noticed such along these latitudes, sometimes more to the northward than this, and in lat. 1° N., and long. 44°.

We have here examples at opposite seasons of this current in the western crossing of the Atlantic.

Ship *James Brown* (Captain C. W. Kerlin), January 12, 1856, lat. 8° 43′ N., long. 31° 37′ W.; current 20 miles East. 13th, lat. 5° 30′ N., long. 30° 21′ W.; 28 miles East. Crossed the equator on the 16th, and experienced a north-westerly current.

Ship *Margaret Mitchell*, January 23, 1854, lat. 4° 36′ N., long- 22° 25′ W.; 13 miles E. by S. 24th, lat. 3° 1′ N., long 22° 30′ W., S. by E. 20 miles.

Ship *Gravina* (Capt. C. Sprague), March 4, 1855, lat. 2° 48′ N., long. 26° 46′ W.; S. 34° E., 17 miles. 6th, lat. 1° 22′ N., long. 27° 43′ W., 12 miles N. by E.

Barque *Eglantine* (Gleason), April 7, 1855, lat. 11° 28′ N., long. 24° 25 W.; current setting to eastward, though the ship was steering S. by W. ½ W.

Ship *Mary L. Sutton* (P. E. Rowland), April 24, 1856, lat. 16° 4′ N., long. 32° 30′ West; current E. 45 miles. 25th, lat. 12° 40′ N., long. 32° 32′ W.; East 10 miles. 26th, lat. 9° 22′ N., long. 31° 20′ W.; East 10 miles. (This is more to the northward than usual.)

Ship *Aetos* (D. McLaughlin), May 18, 1856, lat. 5° 43′ N., long. 24° 44′ W.; 24 miles E. by N. 19th, lat. 3° 39′ N., long. 24° 44′ W.; 14 miles E.N.E. 20th, lat. 2° 56′ N., long. 24° 0′ W., 15 miles E.N.E. 21st, lat. 2° 16′ N., long. 23° 34′ W.; 15 miles E.N.E. 22nd, lat. 1° 20′ N., long. 25° 15′ W.; 10 miles N.E.

Ship *Edwin Flye* (W. Flye), June 27, 1856, lat. 5° 38′ N., long. 26° 17 W.; N. 8° E., rate 1·2 mile per hour. 28th, lat. 4° 5′ N., long. 27° 29′ W.; N. 18° E., 1 mile per hour. 29th, lat. 3° 52′ N., long. 25° 12′ W.; N. 22° E., rate 1·3 mile per hour.

Ship *Panther* (N. G. Weeks), August 19th, 1854, lat. 7° 57′ N., long. 25° 54′ W.; 24 miles E. by S. 20th, lat. 6° 55′ N., long. 23° 28′ W.; N.E. ¾ E., 48 miles. 21st, lat. 5° 41′ N., long. 20° 30′ W., 48 miles N.E. by E. ¾ E. 22nd, lat. 4° 56′ N., long. 18° 7′ W.; E. by N., 1·2 miles per hour. 23rd, lat. 2° 41′ N., long. 20° 4′ W.; 1 mile per hour S.E. by S.

Barque *Mea* (B. Buxton) August 27, 1849, lat. 5° 57′ N., long. 19° 32 W.; half knot N.E. 28th, lat. 4° 12′ N., long. 17° 33′ W.; half knot N.E. 29th, lat. 4° 0′ N., long. 19° 47′ W.; 6 miles E.N.E.

Brig *Director* (Capt. Skinner writes :—" You perceive that I had a strong current between lat. 7° and 5° N. on Sept. 7—10. Not getting an observation for four days, I found the brig nearly 3° farther East than I expected; whether I had it in one, two, three, or the fourth day, I cannot say, but suppose I had some each day. I was speaking with several captains, and they say that they have always found a strong current about them going to the eastward."

Captain Maury adds—" An eastwardly current is often found North of the line in summer and fall; and at those seasons it may be counted on with some degree of certainty." (This refers to the western crossing of the equator recommended by Captain Maury.)

Ship *Flying Dutchman* (A. Hubbard), October 12, 1854, lat. 8° 55′ N., long 40° 52′ W.—" I notice for the last two days (from lat. 11° 18′) the lines of agitated waters, previously noticed, appear all to run nearly E.N.E. and W.S.W., and follow each other at regular intervals of some 4 or 5 miles; the motion of the waves running at right angles to the line of rip. October 14, lat. 6° 46′ N., long. 39° 4′ W.; current East, 1 knot. 15th, lat. 6° 50′ N., long. 37° 26′ W.; current East 1½ knot. One year ago last July I experienced a similar current in the same latitude, but some

10° farther East. October 16th. lat. 6° 49′ N., long. 36° 25′ W.; current East 1½ knot. 17th, lat. 6° 29′ N., long. 35° 18′ W.; current S. 89° E., 2 knots. 18th, lat. 5° 59′ N., long. 35° 19′ W.; current East, northing 1½ knot. 19th, lat. 5° 43′ N., long. 33° 33′ W.; current East, southerly 1½ knot, slight current rips. Oct. 20, no current. All these days generally calm, or light variable airs."

Ship *Raven* (J. Crocking), Oct. 27, 1855, lat. 6° 18′ N., long. 26° 50′ W.; current N.E. 1 mile. 28th, lat. 5° 24° N., long. 29° 50′ W.; current N.E. 1 mile. 20th, lat. 5° 10′ N., long. 30° 1′ W.; current N.E. 2 miles. 30th, lat. 4° 40′ N., long. 30° 0′ W.; N.E. 2 miles.

Ship *Robert Patten* (G. S. Paine), Oct. 30th, 1856, lat. 10° 14′ N., long. 33° 50′ W.; "tremendous tide rips, the strongest I ever saw." October 31, lat. 8° 26′ N., long. 32° 28′ W.; current changes to eastward ½ knot per hour.

Ship *Scargo* (N. Crowell), Oct. 4, 1856, lat. 6° 53′ N., long. 25° 13′ W.; 24 miles East. 5th, lat. 6° 25′ N., long. 24° 42′ W.; 18 miles E. by S. 6th, lat. 5° 36′ N., long. 24° W.; 18 miles E. by S. 7th, lat. 4° 48′ N., long. 23° 29′ W.; 18 miles E. by S.

Schooner *Thomas A. Ward* (J. D. Hoff), October 12, 1855, lat. 6° 5′ N., long. 27° 40′ West; the last twenty-four hours have been the most calm that I ever saw, not a breath from any quarter, and a terrible rolling sea. We drifted S.E. 35 miles.

Ship *Colorado* (Ricker), November 1, 1855, lat. 5° 51′ N., long. 21° 54′ W.; current 20 miles S.E. 2nd, lat. 5° 22′ N., long. 20° 55′ W.; 29 miles S.E.

Barque *Clara* (E. Cook, jun.), December 9, 1854, lat. 6° 48′ N., long. 26° 56′ W.; 1·3 knot per hour N. 35° E. 40th, lat. 6° 9′ N., long. 27° 57′ W.; 1 knot. N. 62° E. 11th, lat. 6° 10′ N., long. 26° 46′ W.; 0·8 knot N. 37 E.

The foregoing are the principal notices of the easterly current as recorded in Capt. Maury's Sailing Directions, vol. ii., eighth edition, and, in fact, is nearly all that is mentioned on currents, as but very few, if any, of the abstract logs quoted in that work mentioned any westerly or other currents, the only exception being that in some very few cases a notherly set is noticed. Besides this, there is frequent mention of current or tide rips, often of a very formidable character, denoting great activity and change in the currents of this troublesome region.

(193.) One of the most remarkable examples of this easterly current recorded, and one which unmistakeably demonstrates its existence and activity, was encountered by John Alexander Mann Esq., F.R.G.S. and F.R.A.S.* He left Cayenne in French Guiana, in the brigantine *Monte Christo*, 120 tons, bound for Paranahyba, on July 26, 1862, the day of the new moon; the wind blowing from the East. A direct northerly course was steered until the 30th, when the ship was in 7° N., and the log, by dead reckoning, was the same as Cayenne, *i.e.* 52° 14′. On August 7th, spoke the Austrian brig *Rarita*, which gave longitude 27° 24′; that of the dead reckoning of the *Monte Christo* gave 42° 14′, so that the vessel had been drifted *nine hundred miles* to the eastward, and for eight consecutive days she had been drifted 3¾ knots an hour to the E.S.E. There was a great doubt as to the accuracy of the longitude, but at noon of the 15th, in lat. 0° 45′ S., they spoke to a Dutch brig, which gave the longitude as 27° 8′, while the

* See Proceedings of the Royal Geographical Society, Vol. VII., 1863, pages 50, 51.

D.R. placed them in 44° 0′, which, compared with the position on the 7th, shows that they were drifted 120 miles further to the eastward. In fact, had the ship been left to the current, it would have soon reached the African coast, having drifted 1,020 miles in 20 days.

Throughout the remainder of the voyage, which lasted 14 days longer, the same current was experienced. The captain of the *Loyal*, which arrived some days after, abandoned his chronometer from the same cause, believing it to be out of order. Afterwards, in sailing from Surinam to Cayenne, in the *Alecton*, French man-of-war steamer, Mr. Mann met with the same phenomenon.

(194.) These facts are very important, in connection with the westerly crossing of the Equator, which has been strenuously advocated, and the influence of this powerful current, which appears to have much constancy during the northern summer months, may have much to do with the readiness with which vessels, having reached too far to the westward, contrive to weather the eastern extremity of Brasil. This will be adverted to hereafter.

(195.) The easterly current thus passing across the Atlantic strikes the coast of Africa about Sierra Leone and the coast of Liberia. Of course, when near the shore, it assumes its direction to the S.E., and runs with great velocity. As is shown by the Chart of the Currents, at page 312, its mean annual velocity is between 14.1 miles and 26.5 miles per day, strongest in the summer months.

Its mean direction off Cape Palmas and Cape Coast Castle is E. 12° N., and its calculated velocity from Major Rennel's and Maury's observations is—for January, 17·4 miles to 27·6 miles; February, 26 miles to 32 miles; April, 11·5 miles to 33·7 miles; May, 22·7 miles to 36 miles; June, 30 miles; July, 18·2 miles; August, 15·7 miles to 26·4 miles per day. These are from the records of 75 observations.

(196.) It southern edge appears to be in about 2½° to 2° N. up to the head of Bight, and as the southern streams set in an opposite direction, they are serviceable in making a return passage as presently explained.

The temperature of the Guinea current is high, and demonstrates its equatorial origin, although the branch of it which comes from the northward past Cape Verde has probably a lower temperature as coming from a higher latitude. The equatorial current to the southward of the Guinea current is also of a lower temperature, coming direct along the African coast from the southern polar regions. The mean summer temperature is about 78°, but in our winter and autumn months it is higher, being from 82·6° to 83° as a mean, and sometimes it is found higher than this.

(197.) H.M.S. *Challenger*, in crossing this current, made the following observations on the temperature of the sea at different depths. From the Cape Verde Islands, 300 miles West of Cape Verde, her track was in a general south-easterly direction for 88 miles to a position 150 miles S.S.W. of Sierra Leone; thence, in the next two days, she proceeded to a position 160 miles to the S.S.W., or 310 miles from Sierra Leone. The date of this passage was August 10th to 21st.

Temperature Observations, in degrees (Fahrenheit), by H.M.S. Challenger, while crossing the Guinea Current in August, 1873.

Position of Ship.	19° N. 24° W.	18° N. 24¾° W.	13½° N. 22¾° W.	12¾° N. 22½° W.	10½° N. 20½° W.	9¼° N. 18½° W.	8° N. 17½° W.	7° N. 16° W.	5¾° N. 14¼° W.	3° N. 13° W.
At the Surface ..	74	74	79	79	78	78	78	79	79	78
25 fathoms	—	—	—	60	69	65½	—	—	72	—
50 „	—	68	—	54	59	59	63	61	62½	65
75 „	—	—	—	53	55	55	—	—	59	61
100 „	57½	62	52	51	53	54	56	55	56	57
200 „	54½	52	50	48½	48½	47	50	49½	53	51
300 „	50	47	46	46	43	45	45	43	43	42
400 „	46	43	42	42	42	41	41	41	40	40
500 „	43	42	40	40	40	41	41	40	40	39
1000 „	38	38	38	—	38	—	—	38	—	—
1500 „	—	36	36	—	—	—	—	37	—	36

The above table, it must be remembered, refers to the time of year at which the Guinea Current is at its greatest power. Subsequently, in returning home, the *Challenger*, in the passage from Ascension to the Cape Verdes, in April, 1876, found the surface temperature in lat. 2° 30′ S. to be 82½°; in 0° 15′ S., 81½°. In lat. 3° N., long. 15° W., 300 miles S.W. of Cape Mesurado, the temperature was 83° on the surface, in the same position in which a temperature of 78° only was found in August, but the warm water did not penetrate to so great a depth. At 50 fathoms, 65° was found in August, but only 59° in April. Sir Wyville Thomson remarks—"Where the rate of the current is highest, we have as usual a rapid fall in the temperature below the surface. This is caused by the cooler water rising to supply the place of the hot surface water, which is being rapidly drifted and evaporated away."

(198.) At the distance of about 59 leagues South of Cape Palmas (long. 7¾° W.) the outer border of the Guinea current sets to the East; and the same directions of it continues to a similar distance South of Cape Three Points (long. 2° W.); we thence, at 2° North of the Line, find it take a more northerly course, toward the Bight of Benin and the Bight of Biafra; in the latter it mixes with the waters of the *South African Current*, which, coming from the South, sets thence to the North and N.W., and both, uniting, form a head in the bight. From this bight and southward of the Equator the currents thus blended set to the S.W., W.N.W., and N.W. in one expanding and uniting stream, which greatly facilitates the passage of ships from Fernando Po to Sierra Leone.

The prevalence of the Harmattan wind, which has been described (p. 228), must interrupt the course of this current; but its existence, at other times, nearly as described, has long been confirmed, and is incontestable.

(199.) Near Cape Mount the current sets in toward the shore as above

stated. The ship *Charles*, a French whaler, in 1833, was wrecked on the coast of Liberia, in about 30 leagues to the S.E. of Cape Mesurado, probably on the reefs near the River Sestros. This vessel had left the port of Havre for the fishery near *Tristan da Cunha*, in the Southern Ocean, but the captain, intending to run along the coast beyond Cape Palmas, in the hope of falling in with whales, unfortunately lost his reckoning, by being deprived, for forty-eight hours, of all means of taking observations; and was moving at the estimated rate of 7 miles an hour, when he found himself close on shore in the midst of breakers, which in the course of the night forced him on the reef, and dashed the ship to pieces. The captain and crew got safe to land, but were soon stripped by the blacks, and the captain himself left without covering. In this condition they made their way along the shore to the N.W., until they reached Cape Mesurado, where they were received with all kindness by the colonial agent of Liberia, who sent them in a small government schooner to the Isle of Goree. The catastrophe is evidently attributable to this easterly current.

On the western side of Cape Palmas it sets along shore with such force to the S.E., that ships which do not steer a point nearer than the true course will be carried from the land. About *Cape Three Points*, likewise, the stream runs strongly to the eastward, and frequently sets directly in upon the reefs about that cape. Eastward of this cape the current has carried many experienced mariners, bound to Cape Coast or Annamaboe, to leeward of those ports, and occasioned much trouble, with delay, in beating up again. About *Terra Formosa*, in July and August, the current has also been found to set strongly to the eastward.*

Thus far, we have given a general description of this remarkable current. What follows is from the Board of Trade Monthly Analysis, 1872, with which is incorporated further information gained from a study of Captain Toynbee's work on the Meteorology of the Area included between lat. 20° N. and 10° S., and long. 10° to 40° W., published by the Meteorological Office in 1876. See the Diagrams illustrating the Best Monthly Routes across the Equator.

(200.) The observations on the western portion of the Guinea Current are neither as complete nor as numerous as might be wished, nevertheless they lead to the conclusion that from the 20th meridian westward this current undergoes periodical changes. We shall make this evident from a tabular statement of the information yielded by the charts, illustrating the above-mentioned works:—

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* In the *Derrotero de las Antillas* the following remarks are said to have been found among the papers of the deceased Admiral Don Josef Varela. "At Prince's Island, and in its vicinity, the waters generally run to the *North*, which circumstance ought to be kept in mind in making the island, and steering for the anchorage. There are also currents to the *South*, but they are not so strong, or of so long duration. The pilots of the place say that the currents depend on the phases of the moon, but we found that they were irregular." From this we may infer that there is some irregularity in the outset or revolving current; for which consequently, every precaution should be taken.

GUINEA CURRENT.

Chart.	Commences in—	On 20th meridian flows between latitudes—
General	50° W. 8° N.	3° and 10° N.
January	25 6	2 „ 10
February	26 10	*1 „ 12
March	28 13	4 „ 12
April	25 6	2 „ 12
May	35 2	3 „ 10
June	30 6	3 „ 8
July	42 6	4 „ 12
August	45 7	4 „ 15
September	37? 8	3 „ 14
October	50? 7	3 „ 10
November	30 6	3 „ 10
December	23 5	*3 „ 10

It thus appears that the Guinea Current has its maximum extent in August, reaching to 45° W., and occupying 11° on the meridian of 20° W.; and having its minimum extent in December, attaining long. 23° W., and having a width of only 7° on the meridian of 20° W. From December to August it is extending its longitude westward and widening northward; and from August to February it is losing its extension westward, and its northern limit is retreating southward again.

(201.) In *January* the Guinea Current appears to originate about long. 25° W., lat. 6° N.; at long. 20° W. it extends from lat. 2° to 10° N. Here it is joined by the North African Current, which checks its tendency to the northward, and the united waters flow eastward along the coast of Guinea, being traceable nearly to Fernando Po. From its origin to Cape Palmas its rate is from 10 to 15 miles per day, but off this cape it acquires a greater velocity, ranging from 13 to 35 miles per day, which it maintains until it reaches the meridian of 5° E. The southern limit of this current is probably about lat. 2° N., but observations are here wanting.

In *February* it commences in long. 25° W., lat. 10° N., but is seldom felt so far West. From the 20th meridian it is well defined up to Fernando Po, trending southward to St. Thomas, its southern limit being about lat. 2° N. From 20° to 10° W. it has a rate of about 10 to 20 miles in the 24 hours, and seems to be occasionally reversed, from 7° to 0° W.; its rate has been observed to be as much as 44 miles, though this can hardly be usual; further eastward the rate varies from 13 to 24 miles. An eddy current is indicated in the Bight of Benin.

In *March* the Guinea Current can be traced from lat. 13° N., long. 28° W. At first it appears as a weak current having a rate of 5 to 10 miles in the 24 hours; but near the African coast, and in about the region of 2° N. and 18° W., its velocity increares to 20, 30, and 40 miles, the strongest current being marked on its southern limit.

* During February and December frequent *westerly* currents have also been reported here.

In *April* it commences in about 6° N. 25° W., and rapidly widens till it extends from 8° N. to 2° N. on the 20th meridian, with a rate of 12 to 23 miles. It maintains about the same rate to long. 8° W. Between 5° and 0° W. its rate is from 26 to 36 miles; further eastward it loses strength, and either dies out in the vicinity of Fernando Po, or is deflected southward, and drawn in with the Equatorial Current. The current has been observed to run strongly to the southward in lat. 12° N., 28° W.

In *May* it seems to be felt at times as far West as 35° W., about lat. 2° to 5° N. In 30° W. it is farther North, and on the 20th meridian it lies between lat. 3° and 10° N. Along this route its rate is from 13 to 33 miles. As it nears the African coast it is felt at times as a northerly current, probably influenced by the wind. Here, too, its rate is from 12 to 13 miles. In the Gulf of Guinea it is easterly, the rates varying from 16 to 45 miles.

In *June* the Guinea Current probably commences about lat. 6° N., long. 30° W. Thence it spreads northward and southward, so that when it crosses the 20th meridian its width is from lat. 3° to 8° N. Its rate thus far is from 15 to 20 miles. Between 20° and 25° W. the North African current is running strongly to the southward between lat. 8° and 18° N. The southern portion of the Guinea Current finds its way, but with coniderable northing, into the Gulf of Guinea. Here its rate is strong, from 16 to 36 miles, and it appears to be confined within narrow limits of latitude. A counter current has been observed in the Bight of Biafra. Captain Toynbee remarks: "The easterly current on the coast of Africa has become stronger since May. Perhaps this may be accounted for by the fact that the N.E. Trade extends much further North than in the winter, drawing more water *off* Africa, whilst there are fewer westerly gales in the North to heap water against Africa, hence the deficiency must be made up by an increased easterly current near to the Equator. It will be seen that it does increase in amount, and becomes more north-easterly near the coast of Africa as the summer advances.

In *July* it is indicated about 6° N. and 42° W., if the observations here are trustworthy. Observations are wanting to the eastward till it crosses the 35th meridian, between lat. 7° and 11° N. In long. 20° W. it extends from 4° to 12° N., its rate being from 15 to 20 miles a day. A portion of its waters is turned to the N.W. by the coast about lat. 10° N., and passes to the northward past Cape Verde, but the main current passes into the Gulf of Guinea, attaining a rate of 28 miles. Between the meridians of 10° W. and 0° there are no observations of this current, but it is shown eastward, between the coast and lat. 2° N., where its rate is from 32 to 11 miles. Although the western limit of this current is not well defined, the data show that its rate and extent are remarkable.

In *August* the Guinea Current is indicated between lat. 8° and 10° N., in long. 45° W., and from 40° to 30° W. there are but few observations. It appears, however, to be running at a velocity of from 15 to 20 miles an hour in this region to the southward and northward of East. At 30° W. it extends from 5° to 12° N. latitude, and at 20° W. from lat. 4° to 15° N. At this part its rate is between 10 and 25 miles per day. Farther eastward it is stronger, and off Sierra Leone has a velocity of 50 miles, with direction

northward of East. Abreast Cape Verde it neutralises the North African Current.

In *September* it can be traced to 37° W. longitude. In long. 30° W. it extends from 5° to 10° N. latitude; in 20° W., from 3° to 14° N., and its rate is from 8 to 32 miles. It maintains about the same rate in the Gulf of Guinea, where its southern limit is about lat. 1° or 2° N. Its velocity is increased to 30 and 40 miles in the 24 hours in rounding the Coast of Liberia. It appears to neutralise the North African Current in about lat. 12° N. 3 southward of Cape Verde.

In *October* it has been noticed in 50° W., between 5° and 10° N. Thence to 30° W. there are only a few observations. At 30° W. it extends from 6° to 10° N., and at 20° W. from 3° to 10° N. Both the rate and set are variable, though the general tendency towards Africa is evident. Between 15° and 20° W., and 4° and 8° N., it appears as a strong current, with a velocity of 30 to 40 miles in the 24 hours. In the Gulf of Guinea its rate is greater, but nowhere exceeds 23 miles. The isotherm of 80°, in lat. 3° N., seems to mark the border of this current.

In *November* it cannot be traced farther than 32° W. At 30° W. it extends from about 4° to 10° N , and at 20° W. from 3° to 10° N. It appears to be now losing strength and regularity. From 20° to 10° W. the observations are deficient in number. Off the S.W. Coast of Africa it runs more to the southward of East than in previous months, indicating the effect of the westerly winds North of the N.E. trade, driving water against Africa, which runs to the southward. In the Gulf of Guinea it is also feeble and unsettled as to direction.

In *December* the Guinea Current is indicated in 23° W., latitude 4° to 6° N. The set is irregular, and the rate feeble, from 11 to 14 miles. It has contracted in breadth since November. At longitude 18° W., its breadth is probably from 3° to 10° N. latitude. Thence to longitude 10° W. observations are wanted. The current has been observed far to the westward in this month, in one or two instances between lat. 6° and 8° N., and long. 35° and 40° W., and also in 47° W. and 5° N. In the Gulf of Guinea it flows between the coast and lat. 2½° N., at a rate varying from 20 to 36 miles.

4.—THE SARGASSO SEA.

(202.) The central portion of the Atlantic, which is comprised between the Trade wind and Anti-trade wind systems (19), p. 182, also bounded on the South by the westerly drifts of the Trade winds, and to the North by the easterly current, presently described, appears to be in a different physical condition to the other portions of the Atlantic Ocean, and indeed from any other portion of the globe.

Its apparently chief characteristic is well expressed by the name now usually applied to it—the *Sargasso*, or *Weedy Sea*. The well-known gulf-weed, which is found more or less over its whole area, seems to be quite

peculiar to it. There may be a somewhat analogous physical conditions in the North Pacific, but this is not so easily defined. This gulf-weed is constantly found, in greater or less quantity, scattered over its whole area, and when it is found in places not its usual habitat, it may be safely inferred that it has drifted out of this extensive area by the action of the current.*

(203.) It is very difficult to define the limits within which this gulf-weed is found. It is more than probable that the fluctuations of the season greatly affects them, as it does the limits of the Trade winds and intervening calms, the more particularly as it is to the varying currents caused by these winds that the weed is retained in its locality. Consequently we may look for its North and South boundaries more to the southward during the northern winter months, and the reverse during the summer. The tropic, or about the parallel of 23° N., may be its southern edge in the longitude of the Azores, from whence this limit extends to the Virgin Islands and the Bahamas. Its northern edge runs from the Azores to the outer edge of the Gulf Stream off Cape Hatteras. It is not so abundant to the westward of the meridian of the Azores. This will give a breadth of 1,000 miles in its eastern part, and a length of 3,000 miles from East to West. As before stated, its limits may change greatly at different times, but it may always be looked for within this area, that is between the southern edge of the Gulf Stream and the northern limit of the Equatorial Current.

(204.) There has been much speculation as to the causes and conditions which have made and retained this peculiar area in its integrity.

Major Rennell says:—It has been observed that the waters of the Atlantic have a greater tendency toward the middle of the ocean than otherwise, and this seems to indicate a reduced level, forming a kind of hollow space or depressed surface. It is certain that the setting of the currents is such as might be expected to take place if such a hollow existed; for the currents do really set into the Sargasso Sea from the North and from the South; whilst in the middle part, although within the region of the Trade wind, the currents are not regular, but indicate a kind of vortex.†

By others it is considered as an immense eddy or whirlpool, formed by the inclination of the water to the westward, caused by the influence of the Trade winds and the Gulf Stream.

Others, again, argue that it is a raised surface, maintained in a quiescent condition by the surrounding currents, and retaining all that is poured into it by the surrounding influences.

It is also considered as the grand receptacle of the Gulf Stream, which, recurving at the Azores here, turns into this space all that it has transported through its long course.

All these theories have some facts to bear them up in some degree, but others can be adduced to show their futility.

(205.) It is here urged that a simple explanation can be given of this

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* A good account of this weedy sea, which is called by the French "Mer de Varec'h," by Capt. Leps, of the French navy, is given in the "Annales Hydrographiques," 1857, p. 565, &c. As the conclusions thus arrived at entirely accord with the particulars given in this volume, it has not been thought necessary to quote from it.

† Rennell's "Investigation," p. 72.

curious region, in the analogous condition of the atmosphere, so powerful an agent in the production or alteration of ocean drifts and currents.

By referring to Maury's Trade Wind Charts, cited on page 195 (34), it will be seen that there is an uncertainty about meeting with the northern edge of the N.E. trade-winds through an extent of at least 10° of latitude; add to this the vibration of this zone of trade-winds consequent on the motion of the sun in the Ecliptic, which amounts to from 5° to 8° in latitude, as exemplified in the diagram of the limits of the trade-winds at page 196, we have a range of 15° to 18° of latitude over which, during some portion of the year, and over a large section of it throughout the year, that there is nothing but light airs and variable winds, being, in fact, the "horse latitudes," *see* page 229 (73 to 77).

Under this zone, therefore, the sea is subject to no continued or regular drift, and consequently whatever is thrown on to its surface will remain for a long time, and the Sargasso, or gulf-weed, being one of the few marine plants which lives when broken from its rocky bed, it may exist here for a very long period, and thus accumulate by the fresh additions constantly making by the outer or eastern edge of the Gulf Stream, as well as that drifted around the northern part of the Atlantic, and passing with the S.E. current by the Azores (328) into this quiescent zone. That the Gulf Stream is the primary feeder to this weedy sea will be shown presently.

(206.) There is another condition also which favours the maintenance and growth of this peculiar plant. The temperature of this water is very equable, less warm than that under the more vertical sun, and not varying more than 6° or 7° Fahr. throughout the year in the eastern part, or 8° or 9° in the western part. This temperature is, as said, lower than that of the southern part of the great equatorial streams to the South of it, but it is higher than that of the current, which sets S.E. and S. between the Azores and Spain, and lower than that of the surface of the Gulf of Mexico and the early course of the Gulf Stream. It may, therefore, be considered that it approximates to the water-climate of the bottom of the Gulf of Mexico, that of the sea around the Bahamas, &c., where it is known that this weed grows naturally.

(207.) The *Sargasso*, or *gulf-weed*, which is its peculiar characteristic, is one of the few plants, aquatic or terrestrial, which will live and flourish when separated from its native stem. Its appearance is too well known to require any detail. The sea was called *Sargaçao* by the early Portuguese navigators, from the weed bearing berries like grapes, "sarga." This term has thus been corrupted into *Sargasso*, and been applied to the plant itself instead of the place it grows on. There are more than one species of it known to botanists, as *sargassum valgare*, &c. It is frequently called *fucus natans*—floating sea-weed; and is known to sailors as *gulf-weed*, that famous stream being always more or less marked with it.

(208.) There are several species of the sargassum, distinguished by the form of the leaves and the fructification. These different species are more or less abundant in different localities.

The old story of Columbus, who had much difficulty with his men, when they declared that even the sea changed its nature into terrestrial to pre-

vent his proceeding on his discovery voyage to America, has been oft repeated.

The sea is commonly studded over, like an inundated meadow, with the bushes, which are in some places very abundant, and in others more dispersed. "If we could imagine the surface of a wide extended moor, covered with water, the furze and heath bushes would appear something like the clusters of fucus scattered over the thickest part of this sea."

The fructification of all sea-weeds is peculiar, but they require a fixed basis to vegetate. Although apparently flourishing in vast areas in this Sargasso Sea, they can only be looked on as cut flowers rather than as complete plants, although their constitution enables them to live a long period without being fixed to their parent rock like most other algæ. They are found in every state of decay, and when old they become covered with minute and beautiful parasitic growths, which deserve much attention to those who have the leisure and taste to examine them, especially with the microscope, which in this region reveals a vast and little known world. Besides this, too, the tufts afford protection and shelter to a vast quantity and variety of minute fishes, crabs, and other crustacea and animalculæ, which will afford an inexhaustible fund of interest to the observer. Naturally enough, there is a limit to its separate existence, and when subjected to any change of temperature, or difference of locality unsuitable, by a continuous wind or current, large areas become decayed, die, and sink to the bottom, to be renewed by the continual fresh importations from the Gulf of Mexico.

It is sometimes drifted on to the shores of the British Isles and Western Europe, and appears among the other sea-weeds in the works on algology, but it is accepted as a shipwrecked stranger, not as a native of our shores.

(209.) The Gulf of Mexico abounds with the native growths of the Sargasso weed. It is found attached to the rocks, at the bottom, in most parts of it. The soundings on the Campechè Bank, Chiriqui, the Andros Islands, on the Bahama Banks, New Providence, &c., all furnish the supply of growing plants. The spores (or seeds) of these become attached to these rocks in the manner usual with all algæ, and the young plant grows, not from a root, because the attachment to the rock is not of that nature, till it attains some size, when offering greater resistance to the progress of the continual current than the stalk is able to bear, it becomes detached, rises to the surface, and then is borne onward by the stream till it emerges through the Gulf of Florida by the Gulf Stream. As will be shown hereafter, this stream has a tendency to throw all floating bodies off to the right-hand of its course, it follows, that this weed is gradually cast off into this central area, aided probably by the westerly prevalence of the winds which at times occur in this part.

One opinion may be safely controverted, that which assigns the depths of the Atlantic over which it is found as its native place. The great depth and consequent cold disproving the possibility of a plant living in such extremes of temperature.

(210.)—H.M.S. *Challenger*, in crossing the Sargasso Sea (June 14th to July 1st, 1873), found the current variable, both in strength and direction; in 63° W. 19 m. N.E.; in 59° W. 12 m. N.E.; in 53° W. 6 m. S.S.E.; in 50½° W. 17 m. E. by N.; in 49° W. 18 m. N.N.E.; in 45° W. 6 m. West; in 42° W. 22 m. N.W.; in 38° W. 27 m. N.; in 36° W. 4 m. North; in 35° W.

16 m. E.S.E., and in 32° W. 8 m. S.W. The depth westward of 38° W. was between 2,000 and 3,000 fathoms, with a bottom of oaze, and with no signs of weed, disproving entirely the idea of some naturalists that the weed grows in this locality. Eastward of 38° W., the depth varied from 1,675 to 1,000 fathoms. The temperatures of the sea surface were greater in the western part of the district 73½°, than in the eastern, where it was generally found to be about 71°, at 100 fathoms the temperature was about 66°, at 500 fathoms about 48½, and at 1,000 fathoms about 37½° Fahrenheit.

"The floating islands of the gulf-weed, with which we had become very familiar as we had now nearly made the circuit of the 'Sargasso Sea,' are usually from a couple of feet to two or three yards in diameter, sometimes much larger; we have seen on one or two occasions fields several acres in extent, and such expanses are probably more frequent nearer the centre of its area of distribution. The general effect of a number of such fields and patches of weed, in abrupt and yet harmonious contrast with the lanes of intense indigo which separate them, is very pleasing. These floating islands have inhabitants peculiar to them, and I know of no more perfect example of protective resemblance than that which is shown in the gulf-weed fauna."—*Sir Wyville Thomson.*

(211.) *Captain Andrew Livingston*, on his way from New Orleans to the Strait of Florida, saw large quantities of it; and every one who has navigated the Gulf Stream has remarked the weed in it, or along its borders. Sir Philip Broke and the Baron Alexander von Humboldt say that the stream contains a great deal. Sir Philip says, "We were always surrounded with gulf-weed." Major Rennell adds, "He spoke of that part of the Gulf Stream out in the Atlantic; the others might speak of other parts."

In the second volume of the Colombian Navigator," 1848, p. 220, is a description of the Andros Isles, as lately surveyed, and it is there shown, that in the great sponging district, upon the Bahama Bank, West of Andros, vast quantities of the gulf-weed are produced; and this is one of the beds from which the ocean has been supplied.

On the wood found in the ocean, we have the following remarks, by *Captain Livingston*, whose name has so frequently occurred in the preceding pages:—

"Many persons suppose that the gulf-weed (*fucus natans*) grows upon the rocks about the Bermudas; others, that it originates among the Florida Reefs; and a third party, that it grows upon the water, without ever adhering to anything fixed.

"All these positions seem to me equally wide of truth. Neither on the Bermuda Rocks, nor among the Florida Reefs, has a single branch of gulf-weed ever been found growing upon the rocks; and, among all the gulf-weed met on the ocean, no person has ever found a single tuft with roots, or that, on mature examination, could be supposed, by any person of sound judgment, to have grown on the surface of the water. On the contrary, every stalk of the weed seems to have been broken off short from something to which it firmly grew, and *all the ends* of these stalks are uniformly decayed, or dried up, from the end to a short distance.

"It has been stated, as a well-known fact, that the *fucus natans* grows on the rocks along the Gulf of Paria, and on the coasts of Caraccas, &c. If

this be the case, it is rather strange that it should not rather grow on other rocks and coasts of the West Indies. It has also been stated, that in the whole sea of floating bushes, *Mar do Sargasso*, not a withered plant is ever discovered. This is not true, as I have seen abundance of *fucus natans* in a state of great decay. I note the following from my journal of the *Brilliant*, from Gibraltar towards Havanna: 8th February, 1819, 'the weed much decayed;' 9th, a.m., 'weed passed through, much decayed;' 10th, p.m., 'passed through much decayed weed; I remark, that the further we run to the westward, the more decayed is the gulf-weed;' 13th, 'the gulf-weed begins to look fresher.'*

"These particulars have been given in order to show that I have not spoken at random; on the contrary, actually made my remarks on the spot. Some of the weed was quite brown, and in small fragments, evidently separated into such by its state of decay. It is true, that the weed soon decays when it is taken out of the water, as I have often tried the experiment. The weed is never of a verdant green colour, but seems as if blanched from having been, in some degree, hid from light; I suppose from vegetating under water."

(212.) *Mr. Turner*, and many other botanists, thought that the greater part of the *fuci* (weeds) which we gather on the surface of the ocean, and which, from the 23rd to the 35th degree of latitude, appear to the mariner like a vast inundated meadow, grow primitively at the bottom of the ocean, and float only in their ripened state, when they are torn off by the motion of the waves.

"The causes that unroot these weeds, at depths where it is generally thought the sea is slightly agitated, are not sufficiently known. It has been said, that if the fucus adhere to the rocks with the greatest firmness before the display of its fructification, it separates with great facility after this period, or during the season which suspends its vegetation, like that of the terrestrial plants. The fish and the molluscæ that gnaw the stems of the sea-weeds no doubt contribute also to detach them from their roots.

"On proceeding hence, toward the West Indies, from the 22nd degree of latitude, we found the surface of the sea covered with flying fish, which threw themselves up into the air 12, 15, or 18 feet high, and fell down on the deck. I do not hesitate to speak of an object, of which voyagers discourse as frequently as of dolphins, sharks, sea-sickness, and the phosphorescence of the ocean. None of these objects can fail of affording interesting observations to those who make them their study."

(213.) *Captain Bourke*, in the brig *Archibald*, December, 1815, found large quantities of the weed near the parallel of 20°, to the northward of the Island Porto Rico, and of the eastern part of Hayti; but on the passage through the Bahama Channel, eastward of the meridian of 70°, and on the

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* On the 8th of February, the *Brilliant* was in 24° 17′ N. and 65° 1′ W. On the 9th, in 24 34° N. and 66° 59′ W. On the 10th, in 24° 51′ N. and 68° 39′ W. On the 12th, in 25° 34′ N. and 71° 5′ W. On the 9th, the ship passed the meridian of Porto Rico, and was hence proceeding toward Providence Channel, Bahama. The decayed weed, we have no doubt, had drifted from the central area of the ocean.—Ed.

North sides of Hayti and Cuba, none of the weed was seen. This may be accounted for on the supposition that it was drifted by the current from the great bed of weed to the N.E., as before explained.

Lieut. John Evans, R.N., states:—"In November, 1810, H.M.S. *Belvedere*, in the centre of the Atlantic, lat. 33° 20′, long. 41° 37′, passed through prodigious quantities of *fucus natans*, in line North and South, as far as the eye could see; and, notwithstanding that there prevailed a very heavy swell from the North, their position was not altered. The quantity of this weed met with between the 30th and 36th degrees of latitude is really astonishing; at times you may sail for leagues through it, covering, as a mantle, the surface of the sea. I have often seen it in lines about 300 or 400 fathoms in length (sometimes only a few yards), and frequently in large and small patches of irregular shape, but generally in a circular form. The deep-sea line should be put over the side frequently in this particular part of the Atlantic.

On the 17th April, 1828, at noon, in the Mexican Sea, a vessel under the command of Lieut. John Evans was in lat. 26° 52′, long. 89° 17′. On this day *fucus natans*, or gulf-weed, was seen, in parallel lines, S.S.E. and N.N.W. It was in flower, and completely covered with young barnacles. "From the lat. 25° to 28° in this sea we met with fucus in parallel lines S.S.E. and N.N.W.; it flowers like fern and other *cryptogamia*. In calms the fuci float near the surface, some of the leaves appearing above water; the patches seen in the Florida Stream, and the bunches examined, were old, brown, and covered with young barnacles."

In the year 1825 the brig *Erin*, from the Pacific Ocean to Liverpool, when to the westward of the Azores, passed compact parallels of *fucus natans*, in lat. 39° 59′, long. 33° 46′. The weed was less broken than any they had before seen; the nodules large and of a deep yellow-brown colour, and the lines extending, as far as the eye could reach, in a direction about S. by E., being nearly at right angles with the vessel's line, which was E. by N. The wind was S.E. by S., strong gales and a heavy sea.

(214.) The *fucus natans* is found in localities to the eastward of the Sargasso Sea. For the following communication we are indebted to the late Captain *Thomas Midgley*, and it is a great acquisition to our knowledge of the wide range that this plant has:—

"On my outward passage to Africa, in a perfect calm, at daylight on the morning of the 18th of January, 1841, in lat. 6° 46′ N., long. 14° 56′ W., I found the ship amongst a number of small bunches of weed, and many cuttle-fish shells.

"On carefully examining some of the bunches of weed, I was surprised to find it the true *fucus natans*, or Sargasso or gulf-weed, being in every respect precisely the same as that found in the N.E. trades, but apparently much fresher, having exactly the same kind of oblong, narrow, serrated leaf, same stem, same nodules, and just the same pale yellow colour. The pods were also surrounded with a very fine kind of network (*flustra*), and there were a very few minute barnacles attached to the stem, which scarcely showed any marks of decay; indeed, the two bunches brought on board (which were each about 4 inches in diameter) appeared to have been but

very recently separated from the parent stem, and they each contained a small but very lively crab.

"The lively fresh appearance of the weed, and the two crabs, induced me to try for soundings, and, as the weather was perfectly calm and the water smooth, I was enabled to get a perpendicular cast of 112 fathoms, with a well-armed heavy lead, but found no bottom.

"The weed was in detached and small bunches, and could only have extended over a comparative limited space; for when a breeze of wind sprang up, and the vessel had sailed 20 miles to the eastward, there was not a single sprig or bunch to be seen.

"This weed appears to be unknown upon the Krou coast, for I had two intelligent natives of Sangwin and Grand Sestros on board at the time I picked the weed up, and they severally declared they had never seen it upon any part of the coast.

"The vessel had been perfectly becalmed for fourteen hours previous and two hours subsequent to the time of picking up the weed, so that she gradually drifted amongst it by a current, which I found, by good observations and carefully-kept reckoning, to set E. by S. by compass, very nearly three-quarters of a mile per hour. Temperature of water, when weed was picked up at daylight, 79°, and at noon, 81° Fahrenheit."

(It had evidently been drifted out of the area by the current described on page 339. Its not being known further East is probably owing to the difference of temperature of the sea, which kills the weed before it arrives there.)

(215.) *Mr. Luccock*, in his "Notes on Brasil," has likewise described the *Green* or *Weedy Sea*. He states that it extends from 11° to 35° of North latitude, and from 30° of longitude to an indefinite distance westward. "Here," he says, "the ocean is covered by nodules of sea-weed, from 3 to 18 inches in diameter, somewhat resembling in form a cauliflower when stripped of its leaves. They float lightly on the water, in parallel lines, at a very few yards from each other, and have a yellow-brown colour, like the long stringy fibre which is sometimes seen floating in the English Channel, and which I suppose to be the natural colour of all marine plants, growing deeply beneath the surface of the water. These nodules, or spherules, are composed of a vast number of small branches, about half an inch long, which shoot from each other at an angle of about 40°; hence they multiply continually towards the superficies of the sphere; and each extreme point produces a round seed-vessel. This is little more than one-tenth part of an inch in diameter, is hollow, and contains a small reddish-brown seed, scarcely occupying one-fifth part of the husk. The leaf of the plant springs from the joints of the branches, is oblong, indented at the edges, about 1½ inches long, and a quarter of an inch broad.

"When the nodule is dexterously taken up, all the branches may be traced to one principal stalk; and this invariably shows a fracture, the part by which it has been joined to some larger stem. This fracture is frequently quite fresh, and, in large and vigorous plants, shows distinctly a woody part and a cortex. On the edges of the latter, the first symptoms of decay appear. They become brown, and separate themselves from the wood. This, also, then assumes a darker colour, and exhibits the regular process of disorgani-

sation, just in the same manner as does a slip from a currant or gooseberry bush. In process of time, the whole of the plant assumes a darker hue; and, as it decaps, floats considerably lower than it did. When kept out of the water for a few hours, it becomes harsh and brown, and acquires the peculiar smell of marine vegetables in a state of putrefaction.

"A great number of very minute barnacles are found upon the leaves and stalks. The seed-pod is usually enveloped in a sort of honeycomb work, which may be taken from it, and, when examined by a lens, resembles in appearance the network of a fly's eye. (This is called *flustra*.) Among other inhabitants of the plant is frequently a number of small crabs, perfectly formed, and evidently young, yet vigorous and active; and when a nodule, taken fresh from the water at night, is hung up in a small cabin, it emits phosphorescent light enough to render objects visible.

"The singular arrangement of the plants, in parallel lines, is evidently owing to the wind, whose direction they always observe. Each nodule places itself under the lee of its more windward neighbour, and thus observes the law of floating bodies when exposed to a current of air. Should the wind suddenly change, as it sometimes does, a point or two, in this part of the Atlantic, and blow strong, these lines become broken, and form what are commonly called *fields of weed*. These, however, are generally small, and seldom, I suspect, remain long so disarranged.

5.—THE NORTH EQUATORIAL CURRENT.

(216.) The name which is usually given to the great drifts of the Trade winds, having as wide a range or latitude as 50° or 60°, is scarcely expressive. The *Equatorial* Current, strictly speaking, is the counter-current we have just described. However, the drift which is intended passes to the S.W. and W. of the Azores and Canaries, and from the Coast of Africa to the Gulf of Mexico, northward of the easterly counter-current in the North Atlantic; while the great drift of the S.E. Trade wind, crossing the Equator southward of the counter-current, and running strongly to the N.N.W, along the coast of Guayana, join its strengh to the northern portion, and thus, together, passes through the Caribbean Sea.

The drift of the N.E. trade is not so powerful as that of the S.E. trade, as the interference of the land causes such a great change in the regularity of the winds which certainly must be taken as the greatest cause in the production of these currents. In general it is a very feeble current, and the mean rate has been over estimated in former times by many observers. In its northern limits in the open ocean its annual average, from a careful calculation, amounts to from 8·2 miles to 11·6 miles per day; in its southern and stronger portion it is from 16 to 22·4 miles per day. Westward of the Cape Verde Islands, its mean direction is nearly due West, which is remarkable, considering the northing of the Trade wind. It would seem scarcely necessary to enlarge much upon the rate and extent of this well-known current; but, as it may be interesting to compare individua

experience with that of preceding voyages, we give as heretofore a series of examples by which the ordinary rate and circumstances may be reckoned on.

(217.) H.M.S. *Challenger* (Feb. 15th—March 14th, 1873), in crossing the Atlantic directly between the Canary Islands and Sombrero, the northern extreme of the Caribbee Islands, found the current to flow as indicated in the current chart, p. 313, the velocities however were greater in places. In long. 19° W. the current flowed to the S. by W. at a rate of 10 miles in the 24 hours; in 22° W. 9 miles S.S.W.; in 25° W. 13 or 14 miles W. by S.; in 31° W. 10 miles W.S.W.; in 33° W. 21 miles W.S.W.; in 35° W. 14 miles W.S.W.; in 37° W. 8 miles W.S.W.; between 39° and 42° W. 11 or 12 miles W.S.W.; between 42° and 45° W. 16 miles W. by S.; in long. 46½ W. 12 miles S.S.W.; in 48½° W. 11 miles W.N.W.; in 51° W. 7 miles W.S.W.; in 53° W. 4 miles W.S.W.; in 54° W. 18 miles West; in 55½ W. 15 miles W.S.W.; in 57½° W. 16 miles West; in 69½° W. 16 miles W.S.W.; in 62° W. (70 miles N.N.E., from Barbuda) 10 miles N.W., and off Sombrero 7 miles W.N.W.

The wind observed was about N.E. between the Canary Islands and 35° W., thence East with a little South in it as the Caribbee Islands were approached.

The temperature of the sea surface was 64° Fahrenheit at the Canary's, and increased as the voyage proceeded to 75° at Sombrero. A temperature of about 46½° was found right across, at a depth of about 500 fathoms, and at 1000 fathoms the temperature varied from 37° to 39°. Bottom temperature 34° to 36.

(218.) As it would be beyond the scope of this work to give a series of monthly charts, like those published by our Meteorological Office, although they are very interesting and most important, our remarks must be limited to those verbal extracts from that work, such as has been given previously.

*The Westerly Drift.**—Under this name are included the currents of the vast central expanse of the North Atlantic, bounded on the East by the North African Current, on the South by the Guinea Current, on the West by the chain of the West India Islands, and the northerly and north-easterly portion of the Gulf Stream, on the North by the easterly part of the Gulf Stream, and passing beyond the chart in 40° N. The westerly set may be considered to commence at the 30th meridian. From lat. 1° N., as its mean southern limit, to the parallel of 20° N., the set is more constant and steadier than it is farther northward. Indeed, as the latitude increases the regularity of the set and the rate decrease. Here the latter averages from 12 to 24 miles a day, and this part of the drift enters the Caribbean sea with the equatorial current. Between the parallels of 20° and 25° N. the drift averages from 8 to 12 miles, and can be traced to about long. 63° W. From 25° to 30° N. the set is irregular, and the rate from 4 to 1 miles, traceable also to longitude 63° W. Between 30° and 40° N. the set is so irregular in direction and feeble in force as to lead to the conclusion that here the true westerly wind does not exist.

* By this term it is to be understood that what we call the *North* Equatorial Current or Drift is meant.

From lat. 36° N., long. 65° W., to the Bahamas, along the right edge of the Gulf Stream, we find evidence of a counter current setting to the S.W. then to the South, at about 12 miles a day; and about lat. 28° N., long. 78° W., turning to the S.E., in conformity with the contour of the Bahamas Shoals. This south-easterly current is probably periodical, and seems at times to extend to long. 63° W,, in lat. 34° N., its greatest rate not exceeding 15 miles a day. About long. 64° W. from lat. 20° to 27° N. there is a feeble northerly set, but not supported by many observations.

(219.) In *January* the westerly drift of the North Equatorial Current seems confined to the torrid zone, and to vary from 6 to 24 miles per day. There are indications of an easterly drift in lat. 23° N. Farther North the observations are deficient and conflicting, but indicate a drift to the southward of West.

In the Mediterranean Sea, between long. 0° to 10° E., the inward set from the Atlantic appears to be exhausted; probably the currents here depend on the winds.

In *February* the vast central area of the Atlantic appears to have variable currents, judging from the very few observations recorded for February. The westerly drift of the tropics, if it exists at all, must be very feeble, not averaging more than 8 or 12 miles daily. Between lat. 30° and 37° N., long. 42° to 65° W., the drift seems to be northerly, but the observations are not numerous. See however the remarks relating to H.M.S. *Challenger*, p. 356.

In *March* it does not appear to extend beyond 25° N. latitude. Between 27° and 55° W. observations fairly represent the general westerly set, while they give its rate at from 6 to 35 miles; it has its greatest rates in lat. 5° N.

In *April* the westerly drift may be said to extend to 30° N. The observations differ greatly as to the rate, though they agree in indicating greater strength in the lower latitudes. In mid-ocean, between 30° and 40° N., the directions are variable, and the rates feeble.

In *May*, North of the Equatorial Current to lat. 30° N., and from 25° W., to the West Indies, the general movement of the ocean seems to be to the westward, at a rate of from 6 to 18 miles. In the western portion of this region observations are, as usual, deficient.

In *June* it appears in mid-ocean and towards the Bahamas. It does not extend northward of 30° N. The rates are various, and the observations are altogether scanty, as they are for *July*, *August*, and *September*.

In *October* it is badly represented. The Mediterranean easterly current is well shown, but there is no indication of an inset from the Atlantic, probably from a deficiency of observations there.

In *November* it exhibits a decided set to the southward between 25° and 30° N., and 40° to 60° W.

In *December* the westerly drift seems to maintain its usual gentle flow, but from lat. 20° to 40° N., long. 40° to 70° W., there is scarcely any data.

(220.) In the work (before mentioned in a *note* in 203) by Captain Toynbee, a very full discussion of the direction and strength of the current between 10° S. and 20° N., and from long. 10° to 40° W. is given. Any verbal description of this work would give but a poor idea of its utility, and

it has been thought best to give the information in the diagrams relating to the Best Monthly Routes across the Equator, given hereafter, to which therefore the reader is referred.

(221.) It will be scarcely necessary to recapitulate the evidence upon which the mean rate was set down in the chart of the Atlantic Ocean, before referred to (see (34) p. 195). The General Chart of the Currents, at p. 313, will with the foregoing remarks, fully explain this part of the subject. As the current is well established, we need not extract the numerous observations given by Captain Maury, as they almost all tend to the same conclusion. But the drift of bottles is so marked an evidence, that we give a number of instances which will be very instructive.

(222.) **Bottles.**—The following have been selected from Captain Becher's list, explaining his bottle chart in the "Nautical Magazine," of November, 1852. It has been before quoted from (166), page 313:—

Ship.	Signature.	Where left.			Where found.	Interval Days.	Distance in Miles.	Rate per day.
		Year.	Latitude N.	Long. W.				
			°	°				
Thunder	Owen.....	1833	28·4	25·5	Bahamas	506	2750	5·4
Osprey	.....	1822	13·3	39·2	Bahamas	216	2610	12·1
C. Dunmore	Robertson ..	1828	27·4	28·0	Cuba	437	2530	5·8
Kate	Creswell ..	1825	24·0	19·0	Mosquitia	519	3300	6 3
Wellington	Liddell	1836	17·9	29·0	Abaco	265	4000	15·1
Echo	Belcher	1837	17·3	36·6	Antigua.....	196	1410	7·1
Stratford	Locke.....	1836	14·5	34·4	Jamaica	278	2460	8·9
Osprey	.....	1820	4·1	24·3	Barbadoes.....	139	2220	16·
William Lockerby	Parker	1838	14·1	25·2	Grenadines	169	2110	12·4
Osprey	.....	1820	5·2	24·7	Martinique	322	2300	7·1
Osprey	.....	1822	6·2	15·6	Trinidad	192	2920	15·2
C. McCarthy	Field	1824	22 0	53·5	San Salvador ..	226	1200	5·7
Harlequin	Cunningham	1851	24·7	30·4	Turks Island ..	300	2300	7·6
Calliope.....	Kuper	1843	19·2	30·8	Caicos	375	2250	6·
Two Brothers	.....	1826	C. Verde.	Ids.	Crooked Island..	382	2800	7·1
D. of Marlboro' ..	Thorn	1820	C. Verde.	Ids.	Hayti.....	283	2610	9·2
Nisus.....	Rey	1842	14·5	34·4	Martinique	277	2100	7·6
Mary	Locke.....	1836	14·5	34·4	Barbuda	278	1700	6·
Enterprise.....	Collinson ..	1850	1·1	26·8	Honduras	367	3800	10·3
Investigator	McClure ..	1850	12·4	26·1	Ambergris K. ..	186	3610	20·
Rapid	Messum....	1852	0·5 S.	22·6	Martinique	155	2430	15·6
Sophia	Saxon.....	1848	5·2	40·3	Grenada	151	1320	8·7
Race-horse	Home.....	1835	8·6	52·0	St. Vincent	35	610	17·4
Race-horse	Home.....	1835	1·3	47·8	Tobago	50	1000	20·
Race-horse	Home.....	1835	11·5	61·5	Maracaibo.....	17	240	14·

The mean rate of travelling of all these bottles is 10·6 miles per day. But this average requires several qualifications which will make it considerably higher. The distances are measured *direct*, but it is most probable that these messengers pursued a more or less *devious* course. Again, it will be seen that the bottles thrown out on the northern part of this trade-wind drift have travelled much slower to their destination than those which started from near the equator.

(223.) Besides the above, we add the following examples of bottle drifts from our former editions.

Central Drift to the Virgin Isles.—A bottle from the *Emerald*, Captain Nockells,

bound to Jamaica, 17th December, 1831, in lat. 36° 40′, long., by chron., 12° 32′. Found on the North side of Anegada, 8th January, 1833. The winds for the last three days, previous to the 17th of December, were from North and N.W. to S.W. For eight days preceding these it blew a continued and heavy gale from S.W. and W.N.W.; the barque lying-to the whole time, and drifting from lat. 41° 28′ 227 miles to the northward.

Equatorial Current to Tobago.—A bottle from the schooner *Julia*. William Davidson, master, in lat. 6° N., and long. 40° W., Nov. 6, 1821. Found 7th of March, 1822, near the shore of Little Rocky Bay, Tobago.

Central Drift and Equatorial Currents.—A bottle from the ship *Gambia*, in the River Gambia, lat. 13½° N., in the latter part of 1831. Picked up on the southern side of Virgin Gorda, lat. 18° 30′.

Central Drift and Equatorial Currents.—A bottle from the *Two Brothers*, of Baltimore, in lat. 17° N., long. 26° W. (off St. Antonio), 21st of November, 1826. Found at Acklin's or South Crooked Island, in lat. 22° 12′ N., long. 74° 18′, on the 8th of December, 1827. Hence it appears to have drifted, in a W. by N. direction, from the vicinity of the Cape Verde Isles to the West Indies, under influence of the drift from the N.E. and the Equatorial Current, probably, in the first instance, W.S.W. and thence W.N.W.

Madeira to the West Indies.—A bottle from the ship *Symmetry*, of Scarborough, Capt. Smith, on her way from Leith to Buenos Ayres, off Madeira, 9th of June, 1825. Picked up at Salt Kay, Turks' Islands, after a lapse of ten years, 9th of June, 1835.

Cape Verde Islands to Brasil.—The *Hazard*, of Greenock, August 4, 1812, lost the N.E. trade, in lat. 11° N., long 25° W.; and the wind, under the 12th, varied from West to S.W.; from the 12th to the 17th it generally blew from South, never exceeding one point easterly. Gained the S.E. trade on the 17th, in lat. 2° N. long. 27° 30′ W.; the trade kept southward between Peñedo de S. Pedro, or St. Paul's Islets, and the coast of Brasil (at Rio Doce), and experienced a westerly current amounting to nearly *four degrees*. Attested by Captain J. W. Monteath.

Between Madeira and Brasil.—In the *Jane*, Captain Livingston, April and May, 1824, found a surplus effects of currents, between Madeira and Brasilian Trinidad in thirty-nine days, equal to 1° 19′ 47″ S., and 6° 3′ W.

(224.) The foregoing is a sufficient elucidation of the features, velocity, and limits of the N.E. trade-wind drift of the Atlantic, but as has been before mentioned, particularly in (39 to 45), pages 198—202, the division between the northern and southern systems of wind, and consequently of current, being to the northward of the equator, the South Equatorial Current enters the Caribbean Sea, and increases the force of the Gulf Stream.

THE SOUTH EQUATORIAL CURRENT.

The South Equatorial Current, which passes over the equator in its northern portion, in its direction is, like that of the Northern Equatorial Current, nearly due West. Setting upon the northern coast of South America, it runs with great velocity close in-shore at times, sometimes reaching 100 miles per day, and not unusually 60 miles. It is scarcely necessary to dilate on this current, as it appears to be regularly and constantly met with. Its progress through the Caribbean Sea, &c., will be

dealt with in the next section. For an idea of its strength and direction in the equatorial region, between the longitudes of 10° and 40° W., the reader is referred to the diagrams illustrating the Best monthly Routes across the Equator.

(225.) It will be seen that, throughout the breadth of this ocean, the set of the stream is not to S.W. or N.W., as might be expected from the direction of the trade-winds, which may be taken as the primo mover of these mighty drifts, but *westward*.

This fact would seem to indicate that the rotation of the earth on its axis has more to do with its motion than has usually been attributed to it. But our present knowledge of the subject is not sufficiently extensive or accurate to define what amount of action is due to that source, or how much to the wind, lunar influences, or temperature, all of which combine to produce the phenomena we are considering. Theoretical speculations, however, are not necessary in a practical work, although they may be interesting.

(226.) Arrived at the barrier formed by the line of the Antillas, a large portion of the stream is necessarily arrested, the remainder pouring through the openings, which, between Barbuda and Trinidad, are not in the aggregate 230 miles in width, or not one-half of the range. From this, or other causes, the westerly drift through the Caribbean Sea is not so persistent, probably, as it is in the ocean to the eastward, as will be presently described.

(227.) H.M.S. *Challenger* (in August 21st, September 6th, 1873) crossed the South Equatorial Current from lat. 3° 25′ N., long. 15° W., 420 miles W.S.W. from Cape Palmas, to Cape San Roque; visiting on the way St. Paul's Rocks and Fernando Noronha. She found the currents much as represented in the illustrative diagram, page 313, but having generally a greater velocity; thus, in lat. 3° 25′ N., long. 15° W., the current flowed 9 miles to W.S.W. in the twenty-four hours. Thence she steered direct for St. Paul's Rocks, and in long. 17° 30′ W., found the current setting 23 miles to the N.W. in twenty-four hours; in long. 20° W., 20 miles W.N.W.; in 22° 30′ W., 17 miles N.W.; in 24° 30′ W., 26 miles W.N.W.; in 26° 30′, 21 miles W. by N.; in 29° W. (50 miles E.N.E. from St. Paul's Rocks) the high velocity of 39 miles to W. by N. was found; at 70 miles S.W. of St. Paul's Rocks, 29 miles W.N.W.; midway between St. Paul's Rocks and Fernando Noronha, 25 miles S.W. (South-West); near Fernando Noronha, 21 miles West; at 60 miles S.W. of Fernando Noronha, 27 miles N.W.; at 90 miles East of Cape San Roque, 30 miles W.N.W.; and on the coast of Brazil the currents were generally found flowing to the N.W. and W. as far as 15° S.

The wind at the commencement of this passage blew from the S S.E., but afterwards came more from the eastward. At Cape San Roque its direction was from the S.E. Varying force from 3 to 5 (Beaufort Scale, see p. 176). The temperature of the surface water observed in this passage varied from 77° to 78°. At a depth of 10 fathoms in the eastern and central part of the region traversed, the temperature of the water was 78°, while near St. Paul's Rocks at this depth it was only 77°, and near Fernando Noronha only 75°. At 50 fathoms, in the central part of the district, it was 62° to 63°, and in the western 67°. At 100 fathoms the temperatures were from 55° to 57°, and at 1,000 fathoms 36° to 37°. The higher temperature at 50 fathoms

in the western than in the eastern part of the district, seems to indicate the banking up of the warm water to the westward by the prevalent wind.

(228.) On this current the following is extracted from Mr. R. Strachan's remarks in the Meteorological Report, 1872 :—

The South Equatorial Current commences on the African coast, and seems to extend at times as far as to 3° N. lat., though more commonly here it is not found beyond 1° N. To the first meridian its rate is from 12 to 17 miles. It now extends generally to lat. 3° N., and maintains this limit to long. 25° W., during a course nearly West of over 1,500 miles, at rates changing from 26 to 12 miles per day. It now has a tendency to the N.W., and attains lat. 6° or 7° N., and as a general result, maintains this limit until it reaches the coast of Brazil. Near the equator the mean rate is less than 24 miles per day, and this becomes lower as the latitude increases, so that in lat. 5° N. its velocity is less than 18 miles. For nearly 300 miles from the coast of Brasil and Guiana the direction of the current is affected by the land. Off Brasil, the rate is from 62 to 37 miles per day; off Guiana, it is from 31 to 24 miles. Having passed the 50th meridian, the northern edge of the equatorial merges with the westerly drift, though in some months this is effected in longitudes more to the eastward, even so far as the meridian of 25° W.

The westerly current, which enters the Caribbean Sea, has a rate of 37 to 46 miles North of Trinidad, but the rate decreases as the latitude increases, and in lat. 17° N. it is only 12 miles a day. In this sea the westerly current averages about 20 miles a day. The mean velocity of the Yucatan current is 34 miles, but it flows into the Gulf of Mexico, towards N.W. by N., with a velocity of 41 miles; and at times the current seems to be carried right across the gulf. To the North and East there is no escape for it, owing to the Gulf Stream; hence the check felt in issuing from the Yucatan Channel bears it off to the westward, but not until it has attained its maximum strength in about lat. 23° N., long. 86° W.

There are times, probably, when the Yucatan current is weaker than the Gulf Stream, then a counter current, an overflow from the Gulf Stream, flows round Cape Antonio towards the Isla de Pinos.

The waters of the Equatorial find a passage westward and northward round the Gulf of Mexico, and they keep up a well-defined movement of its water. Probably, in about lat. 27° N., long. 90° W., a considerable portion of the Equatorial Current which passed through the Yucatan Channel finds its way into the Gulf Stream. Hereabouts it would appear that the currents are intricate, and difficult to ascertain by a day's run, from their conflicting influence upon the ship's course.

(229.) *Of the currents in the vicinity of Anegada and Virgin Islands,* Sir Robt. Schomburgk says :—

"It is well known that the tropical current, caused by the earth's rotation, sets to the westward, and its grand movement in these latitudes is directed through the Caribbean Sea; but it is probable that a branch of it, turned aside by the north-eastern coast of South America, sweeps along the Caribbean Islands to the N.W. till it reaches the Bahamas; and it is this branch which at present attracts my particular attention, and in proof of the existence of which I adduce the following remarks : —

"Vessels bound from America to the West Indies, and chiefly to St. Thomas's, frequently find themselves to the North of the Virgin Islands; and this deviation from their intended course has proved but too often fatal, having brought them on the reefs of Anegada when they thought themselves far to the southward of that dangerous island. Nor can repeated occurrences like these be attributed exclusively to errors in the observations for determining the latitude, or to false reckoning."

The American brig *William and Thomas* left New York 28th of October, 1829; made Bermuda on the seventh day after her departure, when, contrary winds retarding her course, land was discovered in the morning of November 15th. According to reckoning, it was supposed to be St. Martin's, but it was fortunately known, on approaching, to be Virgin Gorda, or probably, in the night, the vessel would have gone on the reefs of Anegada.

The English brig *Francis*, bound from Nassau, in New Providence, to Trinidad, cloudy weather having precluded an observation for several days, was supposed to be far distant from Anegada; but making land in the evening, supposed to be St. Martin's, was wrecked at eleven p.m. on the reefs of Anegada.*

The American brig *Lewis*, bound from Philadelphia to St. Thomas's and Maracaybo, and supposed on the day previous to be on the parallel of St. Thomas's, was wrecked on the south-eastern reef of Anegada, 9th of April, 1831.

During his continuance at Anegada, Sir Robert Schomburgk acquired additional proofs of the existence of a north-westerly current. He found on the south-eastern reef several buoys with tyer (coir) ropes attached to them, which appeared to come from St. Martin's. On the 24th of September, 1831, after a severe gale, two buoys were found on the same reef, which had probably been attached to anchors on some ground to the S.E.

On sounding between Virgin Gorda and Anegada, Sir Robt. Schomburgk threw the log every thirty minutes, and, taking bearings of some remarkable objects, the drift was found to be always westerly; and the result appeared to be the same whether the tides set North or South. On one day he left his anchorage, and sailed 10 miles to the northward of Anegada, where the boat was lowered, and rendered stationary by means of a kettle filled with stones, it being then southern tide; in spite of which the log was carried N.W. by W. A similar experiment was made in the waters between Virgin Gorda and Anegada, with the advantage of anchoring; and the set was always the same, the drift being nearly 1 knot.

The north-western or ebb tide between Anegada and Tortola is much stronger than the flood to the S.E.; undoubtedly from the circumstance that tide and current work the same way.

On these circumstances Sir R. Schomburgk observes, that the wind, from March to June, frequently blows from the South and S.E., and the velocity of the N.W. current will be thus increased; in consequence of which, vessels bound during that time for these islands are more subject to error in

* A great quantity of cork shavings are washed annually ashore on the North side of Anegada. They are drifted by the Equatorial Current from the coasts of Spain and Portugal.

their course than at any other period; and lighter bodies being more influenced by the currents than heavier ones, may be taken as the specific cause of the last remark.

An example of an extraordinary velocity on the northern edge of this current is given by Capt. W. Code.

Capt. W. Code, ship *Albion.*—1857, from August 5th, noon, lat. 0° 36′ N., long. 43° 21′ W., to 6th, noon, lat. 1° 51′ N., long. 45° 59′ W., experienced a current of N. 72° W. 73 miles, although not the slightest rippling or agitation of the sea was visible.

On the 7th, at noon, lat. 3° 50′ N., long. 48° 40′ W., the current was found to have been N. 61° W. 108 miles. Surprising current; measured log lines and log glasses which are correct, so there is no doubt that the current has carried the ship the distance noted.

(230.) The *Rollers*, or *Heavy Ground Swell*, off the north-eastern portion of the Antillas, which has from time to time produced so much mischief, was first described by Sir R. H. Schomburgk, as shown in the Journal of the Royal Geographical Society, 1835, and copious extracts from the same are given in the third volume of the "Columbian Navigator," to which the reader is referred for a complete explication of the subject.

The phenomenon appears to be caused by the meeting and combination of the drift from the N.E., and the Equatorial Current from the S.E. or E.S.E. It rises, rages, and subsides, says Sir R. H. Schomburgk, when the air is calm, when there has been no indication whatever of a previous gale, or even when light airs have, for a considerable period preceding, come from the southward of East. The waves approach in gentle undulations, but suddenly swell against the shore, and break with the greatest impetuosity. The rise takes place sometimes gradually, but more frequently quite unexpectedly, the waves reaching an uncommon height.

A heavy "Ground Sea" is distinguished by something grand and sublime. The sea approaches in undulating masses, which suddenly rise to large ridges, crested with foam, and form billows that burst upon the beach with the greatest impetuosity; the spray flying, where the waves dash against cliffs, often more than 100 feet high, attended with loud roarings resembling thunder, which subside into a rumbling noise, caused by the nodules and fragments of rock with which the breaker was charged when advancing, which on its retreat roll backward, and are again driven forward by the next surge. Wave then follows upon wave in quick succession, there being, apparently, only a short interval after the third. The sea, for many miles from shore, assumes a peculiar aspect, different tints of blue, from the lightest to the darkest, forming a strong contrast with the snowy foam of the breaking waves, when they strike against a hidden rock, or with the white line visible along the whole coast. The Eastern Bahamas, the north-eastern coast of Jamaica and Hayti, but chiefly Porto-Rico and the Virgin Islands, and, in a less degree, the Northern Caribbee Islands, are subjected to this ground sea.

It may be considered as a rule that whenever the wind gets to the northward of East for a day or two, there will be a *ground sea* on the northern side of the islands. The friction of the wind on the surface of the water causes little elevations or ridges, which, by continuance of the force, gradually in-

crease, chiefly when the wind sweeps over a great extent of water. Finding no resistence, and having sufficient depth to sink directly down, they proceed with the direction of the wind, and remain natural waves, until they meet repercussion from dashing against the shore, when they rise to an elevation much above their natural state.

The period when the ground sea sets in is generally *October*, and it continues, though with some intermission, till April and May. The wind accompanying or preceding a ground sea is, generally, from the East of North; the winds are, therefore, propelled, more or less, in a western as well as southern direction, and the Bahamas, and even Bermuda, may escape, whilst the islands from Barbadoes to Porto Rico, but more particularly the latter and the Virgin Islands, receive its first impulse.

A southern gale will likewise produce a heavy swell on the southern side of these islands; and, during the gale of the 30th and 31st August, 1833, this was felt with great violence on the southern shore. But generally speaking, neither in force nor duration are these surges to be compared with those of the northern side; the group of the Virgin Islands being protected, in this direction, by the Caribbean Islands or by the Colombian coasts, and not exposed to the swell of the main ocean.

To one who crosses during a severe ground sea, from the southern side of Tortola to the northern, where the breadth of the island is inconsiderable, the singular spectacle is afforded of the sea, which on the southern side is perhaps "as smooth as glass," on the northern shore tossing, foaming, and roaring, as if agitated by a severe gale. The effect is most curious, and if it were not for the warning that is heard long before the cause becomes visible, one might fancy the wand of a magician in action.

The northern coast of Port Rico is subjected to a ground sea, of scarcely less force, and which has had the same effect on its coast as that of the Virgin Isles. The "Old English Pilot" observes, that the sea along the North coast of Porto Rico "beats sometimes very ragingly." The force of the waves that batter against the cliffs on which the Moro stands is amazing; and any observer will admit that the spray is sometimes carried more than 100 ft. high. It has been said that, several years ago, a brig, in consequence of carelessness, here became unmanageable, and was soon dashed to pieces against the cliffs, but few of the crew escaping.

6.—THE CURRENTS OF THE COLOMBIAN OR CARIBBEAN SEA, AND THE MEXICAN GULF.

(231.) "On the Colombian coast, from Trinidad to Cape la Vela, the current sweeps the frontier islands, inclining something to the South, according to the straits which it comes from, and running about 1½ mile an hour, with little difference. Between the islands and the coast, and particularly in the proximity of the latter, it has been remarked that the current at times runs to the West, and others to the East. From Cape la Vela the principal part of the current runs W.N.W.; and, as it spreads, its velocity

diminishes. There is, however, a branch, which runs with the velocity of about a mile an hour, directing itself toward the coast about Cartagena. From this point, and in the space of sea comprehended between 14° of latitude and the coast, it has, however, been observed, that in the dry season the current runs to the westward, and in the season of the rains, to the eastward.

"On the Mosquito shore, and in the Bay of Honduras, no rule can be given for the alterations of the current. All that can be said is, at a good distance from land, it has generally been found setting towards the N.W.

"In crossing from the coast, or from Cartagena, to the islands, it has been discovered that from La Guayra to the eastern part of Hayti, on a voyage made in December, a difference of 106 miles to the westward was found during the seven days the voyage lasted."—*Derrotero de las Antillas.*

(232.) The Baron Alexander von Humboldt, in describing his passage from Cumana, westward, to La Guayra, said:—"The general motion of the waters between the tropics toward the West is felt strongly on the coast during two-thirds of the year only. In the months of September, October, and November, the current often flows toward the *East*, for fifteen or twenty days in succession. Vessels on their way from La Guayra to Port Cabello have been known to be unable to stem the current that runs from West to East, although they had the wind astern. The cause of these anomalies is not yet discovered. The pilots think that they are the effect of some gales of wind from the N.W. in the Gulf of Mexico; yet these gales are much more violent in spring than in autumn. It is also remarkable, that the current to the East precedes the change of the wind. It begins to be felt, at first, during a calm; and, after some days, the wind itself follows the current, and becomes fixed in the West."—*Personal Narrative*, vol. iii., page 378.

(233.) Captain C. S. Cochrane, R.N., in his *Journal*, March 16th, 1823, says:—"In the afternoon we perceived high land through the haze, and hauled up for it, wishing to make a point about 50 miles to the windward of Santa Marta; but, on getting in-shore, we found that we were 7 miles to the *leeward* of that place, the current from the eastward having been running for the last twenty-four hours upward of 2 knots an hour; which agrees with Baron Humboldt's account, that the current runs from 1½ to 2 knots an hour, according to the force of the wind and season of the year. The natives say, that the moon likewise has a considerable effect on this current, which, at the changes of new and full, runs to the *eastward* for 24 hours.

"Here I must caution all captains of ships navigating on this line of coast to allow for the current, in general, at least 1½ knot per hour, on an average, with an increase in proportion to the strength of the breeze, and an abatement at the new and full moons; otherwise, vessels heavily laden, overshooting their ports, may lose as much as three weeks by having to stand away nearly to the Antillas before they can get sufficiently to windward to gain the port they have missed; and even men-of-war run a risk of carrying away spars and masts in beating-up."—Vol. i., p. 52.

(234.) In the third volume of the "Colombian Navigator," 1839, may be found "Remarks on the Currents of the Atlantic and West Indies, made by

Lieut. A. H. Bisschop Greevelink, in the *Echo*, a brig of the Dutch Royal Navy, during four years of service, 1833—1837," and which describes the route of that vessel from England to Surinam, in August and September, 1833. On the evening of the 13th of the month, the *Echo*, having arrived in lat. 17° N., and long. 35° W., lost the trade-wind, and the wind then shifted to the N.W., with a strong breeze; gloomy weather, and much rain, during the twenty-four hours. The following day the wind, diminishing, passed to the S.W. and S.S.E., and terminated in a calm; currents weak and variable to the S.W. and eastward.

On the morning of the 16th, in lat. 14° 40′, and long. 30° 20°, a light breeze sprung up from the S.E., and from that time till we reached the coast we had to struggle with a never-ceasing variety of wind and weather, continual rains with squalls, and scarce a day passing without lightning in one or other quarter of the horizon. On the 18th we passed by several ripplings or eddies, being then in lat. 12°, and long. 39° 30′ W. They usually stretched from East to West, and were often seen to cover the whole surface, everywhere boiling and bubbling as in a cauldron. Current always weak, and during the last forty-eight hours to the West and W.N.W. at a rate of half a mile an hour.

After losing the trade-wind we had to creep over more than 900 miles, as the wind had left us, in every appearance, for ever; the rains were copious and continual in this space, and lightning was seen very frequently. On the 18th (lat. 11° 52′, long. 39° 25′), we passed through a number of eddies; and on the 24th (lat. 8° 3′, long. 45° 37′), the first indication of a change in the colour of the sea became visible; yet it was slight, and may be attributed to a branch of the northerly current observed in the succeeding day. On the 27th (lat. 5° 52′, long. 48° 38′), we received a gentle S.E. breeze, which brought us, though slowly, toward the coast. In the night of the 28th (lat. 5° 7′, long. 49° 56′), we crossed the edge of meeting currents from the Ethiopic Ocean and Brasilian shore and from the Marañon; after which we entered the boundary of the tides. In the evening of Sept. 30th, came to anchor in 5½ fathoms. In the night observed longitude by chronometer, 54° 11′ 45″.

Although we had not seen land since we lost sight of the Lizard, by which to examine our timekeepers, I felt not the least doubt about their rate (the one a *Knebel*, and the other a *Parkinson* and *Frodsham*), by their reciprocal conformity, corroborated by any lunar observations (which, by-the-by, I think are never to be neglected); and as I was desirous to obtain some observations about the currents, so peculiarly remarkable in these seas, I took every opportunity which circumstances allowed to satisfy my curiosity.

On the 22nd of September and subsequent days the ripplings became less in number; and on the 24th, in the afternoon, about the 8th degree of latitude and 46th of longitude, we perceived the first change in the colour of the water from the common blue to a somewhat darker hue; and, as this was a somewhat uncommon case, I attributed it to a branch of current observed the following day at noon, setting due North, at the rate of more than a mile an hour, straight across a south-easterly current observed during the preceding days, mingling the muddy waters of the Marañon and other rivers with those of the ocean. From the 24th to the 28th nothing particular

occurred; we were always steering to the S.W. with light, variable winds, and a continuance of rain sufficient to penetrate our very bones. Currents, weak and changeable, being lastly observed to run N. by W. 18 miles in twenty-four hours. This, at present, I call weak, being afterward accustomed to fall in with a velocity of twice and thrice that number of miles At noon we altered our course to W.S.W., being then in lat. 5° 7′, and long. 49° 45′ 55″.

In the night, however, having a lunar altitude, we were not a little surprised at finding the ship thrown 35 miles to the northward of her supposed situation, although I may say to have been prepared for this occurrence by Captain Edward Sabine's relation in the "Memoir," whose track we were crossing just then, in the same month.

At break of day we saw the water totally altered in colour, and thickly mingled with mud, as if we were sailing in a flood of ochre; hove the lead, and found 45 fathoms, fine sand, white and black. At seven in the morning, by chronometric observations, I found the westerly offset 33′ 38″; and finally, at noon, in lat. 5° 21′ 49″, long. 51° 46′ 15″, it appeared evident that the current, in the last twenty-four hours, had been running with the rapidity of 67 miles to the N. 30° W. In the afternoon we perceived the land toward the S.W. by S., being the *Family Islands* of Cayenne, and at the same time we entered the boundary of the tides.

This, indeed, seems to confirm the opinion of those seamen who attribute the principal strength of currents hereabout to the waters of the Marañon, &c., predominating over those of the ocean; but this is to be admitted in a partial degree only; for, as operating on the general direction of the Equatorial Current, I esteem it as of no influence at all.

(235). The numerous voyages made by the *Echo*, in the West Indian Seas, with a particular detail of each, more especially in regard to the currents, are given in the volume above mentioned; and from these voyages and experiments the general inductions are, that between the Caribbee Islands and the Coast of Guyana, in the months of August, September, and October, the current veered to the northward of N.W., and in other months more westerly, or even to the southward of West, as in November and December, 1834; but we learn, also, that the greatest velocity of current has been observed in August and September, when the Marañon is at its lowest level, as well as in December and March, when this river begins to increase, and attains its greatest height; even on examining the details, in order to discover any regularity in its force, we find an irregularity reconcileable only with that of the wind; and, more generally, by applying the theory of trade winds, and their influence upon the surface water of the ocean.

After having once rebounded from the Brasilian coast, the United Equatorial and Ethiopic currents are again compelled to retire westward by the influence of the S.E. trade wind (apparently, also by the disposition of the waters in these regions to retire westward); and, although at pressing the Marañon, which disembogues towards the N.E., the combined current may in some degree, according to its variable form and strength, derive an impulse to the northward, yet it soon yields to the force of the N.E. trade

wind, and the south-westerly drift thereby produced, which sets toward the Caribbee Islands.

In proportion to the force and extent of these winds, the general current toward the shore of Guyana, as in December, 1835, and November and December, 1834; or allowed to expand freely to the North, as in August, September, and October; even to the N.E., as in March, 1837, especially when preceded by long and violent indraughts, and followed by calm weather.

By the influence of the Marañon waters, the general current is prevented from sweeping the coast to the westward of Cape North; as the stream of this great river, being unobstructed, seems to gather all its strength, and force the western boundary of that gigantic drift to an uncertain distance from shore. In this manner we may account for the weak westerly current, creeping along that part of the coast comprehended between the Marañon and Gulf of Paria, called the *region of the tides*, and which is produced by the remaining effluxion of the Marañon, confined between the western border of the general current and the muddy banks of Guyana. It is incorrect to fix this border in 9 fathoms of water, as I have found it in twice and thrice that depth; but, on the other hand, I think that if what has been supposed by Admiral Cosmé de Churruca should ever again happen—I mean the destroying of the Equatorial Current by the action of the rivers—the Atlantic will be found of a whitish hue, so far as these currents shall reach, because their thick muddy waters never mingle with those of the ocean until they have been subdued by, and are at rest with, them.*

The direction of currents in the Atlantic is reconcileable with the force and direction of the trade wind, but not without exceptions; because the height of the water-level in the Caribbean Sea will sometimes baffle every calculation both within and without the range of islands, as shown indubitably by experiments founded, not only upon the method of ascertaining currents at sea, but also within sight of land, and observations made on shore along the coasts. It has also been found that during calm weather, even with strong easterly winds, the currents have sometimes been running for days together to the eastward, especially in the latter parts of January and July, when, by the then prevailing strong winds, the water is heaped up in a very uncommon degree, and the inner part of the Caribbean Sea, most probably overcharged, succeeds in re-establishing its equilibrium by forsaking the power of its wrathful driver. In this manner, I think, we ought to reconcile those circumstances mentioned by that illustrious Spanish commander.

In the Caribbean Sea the force and direction of currents are more distinctly modified by the direction of the wind. With continual light winds and smooth water the currents are generally weak, augmenting only in proportion to the increasing wind. This may serve as a proof that, among other

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* The great force of the Maranon current was observed by Captain W. Code, in the ship *Albion*. He says:—On October 8th, 1857, at noon, lat. 5° 14′ N., long. 50° 1′ W., current N. 18 miles. This current must be caused from the waters of the River Maranon. The water is not salt, merely brackish taste, the sea boiling and making a great noise, which I have found seldom to occur when the currents are strong.—"Meteorological Report," 1872, p. 30).

less perceptible causes, under which they are governed here, wind is the most powerful agent; for the indraught through the channels appears plainly to proceed from the force and extent of the trade winds. In this sea, from the Windward Islands westward, to 72° of longitude, the general direction of currents, observed during our four years' cruize, was N.W. and westerly; the weakest in October, November, April, and May, the strongest in December, January, February, and March, along the coast of Venezuela, and in July and August in the northern parts; but, in general, so much always depended on the force of the wind, that, with few exceptions, *almost every voyage was affected by a force of current corresponding to that of the prevailing wind.*

(236.) Extracts from the Journals of Lieutenant Greevelink.—"*In January*, 1834, the *Echo*, in crossing the Caribbean Sea, from Curaçao to windward, experienced a drift of 40 miles to the West, and escaped only by running straight for the coast of Hayti, beating to windward along that and the coast of Porto Rico, with the best success, and even assisted by weak easterly currents when near the shore. Wind from the E.N.E. sometimes blowing a gale; but, when sheltered by the land, the water was tolerably smooth.

"*In December*, 1836, the *Echo*, then on her passage from Surinam to Curaçao, with sharp breezes, found the current sweeping through the channel between Tobago and Granada; and, further on, along the Leeward Islands, with a velocity of more than 2 miles an hour to the W. by N.; but, in October, 1836, on the same route, with light wind and calms, the water ran for days together to the northward, at the rate of only half a mile an hour.

"*In March*, 1836, the same vessel, from Curaçao to La Guayra, with very strong winds, spent six days in beating up against a current of 40 miles mean daily strength; and on the 8th of April left La Guayra for Porto Cabello, in the bight to the westward, when, instead of making this passage in some hours, she had, during three days, to contend with light, variable, and even westerly winds, and currents to the N.E. 15 miles daily.

"The Baron von Humboldt's remark about the increase of the currents near the Testigos proved true on our approach to the same islands, in December, 1835.* In the morning of the 12th, the longitude observed was 62° 45′ 15″, and the difference West in twenty-four hours appeared to be 32′ 15″; shortly after, the cluster of rocks came in sight; and at noon, at the very moment that the sun passed the meridian, the S.W. island, placed by Don J. F. Fidalgo in 63° 12′, bore East, distance one mile, having run by log 20 miles to the W. ¾ N.; so that, during these last four hours, the westerly difference amounted to 8 miles, whereas, in former watches, it was only 5¼ miles.

"A similar circumstance, we have reason to believe, also takes place at other groups of this range of sunken islands, and near such capes as are low and reaching far out, so as to obstruct the motion of the water beneath, and

* The remark is as follows. The Baron, on approaching the Testigos, July 14th, 1799, says:—"During a calm, the current drew us on rapidly toward the West. Its velocity was 3 miles an hour, and increased as we approached the meridian of the Testigos, a heap of rocks, which rise up amid the waters.

thereby redouble the force of the surface current, as denoted by the many instances of shipwreck and carcases of vessels (sad admonishers of precaution) spread among these flat, barren rocks, and produced solely by the irregularity of currents, which baffle every calculation, even those of the coast traders.

"But this variety in the westerly currents here is not the only cause of danger. The total change in the setting of the currents from West to East is of a nature which requires the utmost care and attention, as they not only occasionally happen with calms, but also sometimes with fresh breezes from the eastward. One of the first mentioned instances, particularly remarkable, we observed during our passage in October, from Surinam, through the Channel of Granada, toward Curaçao. On the 7th and 8th, between the Island of Tobago and Cape Malapasqua, the water flowed to the *N. by E.* and *N. by W.*, with a trifling force; when suddenly, on the 9th, we had a difference of 17′ 54″ North, and 34′ *West;* and, on the following day, at the *new moon*, we were driven 11′ 12″ to the North, and 35′ 54″ to the *eastward* of our supposed situation. This case was too singular not to excite our attention, as the high mountains of Caraccas showed us almost hourly the East or westerly direction in which we were driven; the weather being perfectly calm, and the water constantly smooth, by which means we were able to verify ovr chronometrical observations, and to remove every doubt respecting the truth of so extraordinary a circumstance, the result whereof was as follows:—

"By the westerly current we drifted in sight of the high land near *La Guayra*, and kept working up against the strong easterly set in the whole following day. On the 10th, from seven in the morning till four in the afternoon, we had 14 miles difference West, agreeing with the bearing of *Monte Avila*. From that time till six in the evening, when that mountain, of which we had lost sight for a moment by drifting to the westward, again became visible, the water flowed again to the eastward; and on the 11th, at six in the morning, with an observed latitude, and the said mountain bearing S.E. by S., we were in long. 67° 21′; and this by calculation being 67° 47′, we found a difference of 26 miles to the eastward in sixteen hours. From this time till four in the afternoon, again 10 miles to the West; and from thence until the following morning, 22 miles easterly difference. During the night we hove-to to the southward of Caraccas Bay, Curaçao, and were obliged to keep *Little Curaçao* in mind, as the current was setting strongly to the eastward.

"Whether this flux and reflux were caused by the moon (then new), or by any other agent, I shall not attempt to determine. Indisputably there occasionally appear satisfactory reasons for ascribing to that luminary some influence over the currents in these regions, and the above-mentioned case is probably one of them; but, as Captain Livingston says on the subject, 'the winds have a still more powerful influence.' Indeed, when roving in these seas, studying the 'Memoir' and the 'Colombian Navigator,' and enjoying the pleasure of reading all that science and skill have ever produced in the description of these regions, we always meet with Captain Livingston's remarks as so many illustrations, and feel a continued increase of respect for so accomplished a navigator.

"The reflux of the current to the eastward, for some hours daily, we had also occasion to observe, in January, 1834, near the coast of Hayti, Porto Rico, and even in the Atlantic, while working up with smart breezes, and even with very strong winds; and once, in May, 1835, a merchant vessel, steering for Curaçao, with her mainmast broken, passed in the night to the southward of Buen-ayre and Little Curaçao without seeing the land, being totally unacquainted with any existing current, and consequently with her real situation. At daybreak, finding herself opposite the eastern part of Curaçao, and supposing it to be the Island of Buen-ayre, she stood to the West for Curaçao, as she thought; but on her passing the harbour of St. Anna she guessed her error, and tried to gain the entrance, in which she succeeded toward sunset, after hard struggling with a hard wind and a rough sea, but assisted by a current to the eastward.

"It should be borne in mind that the captain of this vessel was unprovided with a time-keeper, from want of which he knew nothing about easterly or westerly currents; and if, on his approaching Buen-ayre, he had accidentally stood a few miles to the N.W., so as to make its northern coast, he would have found a watery grave, designated, perhaps, only by some piece of floating timber, a splinter, or broken spar.

"The uninterrupted easterly currents alluded to have already been mentioned by Baron A. von Humboldt; and, whenever I witnessed them, I found them just as described by that celebrated traveller. It may, however, be remarked that although this change in the general motion of the water is most common in the three months quoted, and chiefly along the Colombian coast, yet sometimes it also happens in other months, and in other parts of the Caribbean Sea; as we, in fact, once experienced it in December, once in April, near the coast above mentioned, and once in March, on our passage from Guadaloupe to Barbadoes, during which, vessels from St. Vincent's made their way toward the same islands in a few hours."

(237.) Mr. Town, in his "Directions for the Colombian Coast," has said:—"Although between the Island of Jamaica and the Spanish Main, westerly currents are most frequent, yet they do not always prevail; for ships have been known to be driven by the current from 50 to 60 miles to the *eastward* in four or five days. From the beginning of May till November (*the rainy season*), the sea-breeze seldom or never blows home to the main; and ships going there should never go to the southward of the latitude of 11° until they are at least 40 or 50 miles to the westward of their intended port; after which they make a South course, as the land-breeze, which is generally from the S.W., and the strong *easterly* current, will set you to the eastward of your intended port, if great care be not taken. When to the eastward, if light winds prevail, you must stand to the northward until you meet the sea-breeze, which will lie between the latitudes of 10° and 11°, and then run to the westward.

"Being off Porto Bello, in H.M.S. *Salisbury*, on or about the 12th of August, 1816, and being a little to the eastward of that port, with light variable winds for several days, the ship was to the *eastward*, at the rate of 30 miles per day; and, having been afterwards placed in the same situation, I found it necessary to make the land well to the westward, and to keep close to it. From November until May (the *dry season*) you should

endeavour to make the land well to the eastward, and run along shore; as the sea breezes generally blow very strongly, and the current sets to the westward at the rate of about 2 miles an hour.

"Between Chagres and Porto Bello, during the rainy season, there is generally a northerly current, at the rate of from 1½ to 2½ miles an hour. After the end of the rainy season the current sets to the southward and westward, and strong southerly and easterly winds prevail here. From November until May (the *dry season*) the southerly and westerly are very light winds, except in squalls, which end with heavy rain. In sudden squalls you will often have the wind from all points of the compass.

"If at Chagres, at any time during the rainy season (May till November), and bound to the eastward, endeavour to get 4 or 5 leagues from the land as soon as you can; for the winds are, in general, very light, and the current very strong. The latter sets from Chagres directly on the rocks of Porto Bello, and thence along the land from E. by N., E.N.E., E.S.E., and according as the land lies; its general rate being from 1½ to 2½ miles in an hour. Great care should be taken when near the land, if a heavy squall and rain appear to be coming on. During this you will have the wind from all points of the compass, and often so strong that all sail must be taken in.

"In crossing the Gulf of Darien, little or no current will be found; wherever there is any, it sets about South, S. by W. or S. by E., up the gulf.

"Near Cartagena the current generally goes with the wind; but off the Islands of Rosarito it sets to the N.W. and N.N.W., from 1 to 2 miles an hour.

"Between Cartagena and the Magdalena, in the rainy season, you cannot put any dependence on the winds or current; but from November to May the trade wind blows home.

"I should recommend, if turning to windward, with strong trade winds, to keep the shore close-to; whereas, by going off from the land, you will not only have a heavy sea, but also a strong N.W. current. If you have light variable winds, approach no nearer ot the land than 4 or 5 leagues, as you may be certain of easterly current."

Captain Livingston says:—"During five weeks in which I remained at *Cartagena*, in June and July, 1817, the current in-shore set constantly and strongly to the northward, at the rate, I am convinced, of not less than 1½ mile an hour, or nearly as strong as the Mississippi at New Orleans. I have seen the *Esk* sloop of war, current-rode against a very fresh sea-breeze, when at anchor, nearly West from the city, distant about half a mile."

(238.) Upon the *Current* between the *Grand Cayman* and *Cape Antonio*, Captain Monteath has said:—"In the months of May, 1814 and 1815 (two voyages in which I was chief mate of the ship *Prince Regent* from Kingston); in June, 1817, in the ship *Fame;* and in April and December, 1820, in the ship *Mary*, between Grand Cayman Island and Cape Antonio, I invariably found the current setting strong to the eastward, or E.S.E.; and I have heard it generally remarked that vessels shaping a course from the Caymans for Cape Antonio have found themselves off, or even to the eastward of, Cape Corrientes: this has, in the above cases, invariably happened to myself."

Further on, "In my passage from Kingston toward Campechó, in the ship *Fame*, June, 1817, between Cape Antonio and Cape Catoche, I found the current to set due *North*, 27 miles, in a run of eighteen hours."

We have already given, in a preceding page, the remarks of the Spanish navigators on the Currents of the Mosquito Shore and Bay of Honduras. We now add those of our friend Captain W. J. Capes, of London.

Captain Capes says:—"Between *Jamaica* and *Bonacca* the current generally sets to the northward and westward. Here, in May, 1816, I was set 60 miles to the westward by the current, and found that it set rather northerly, from one-quarter to half a mile an hour."

"If a ship be lying-to, under *Rattan*, it will not be amiss to try the current. It is my opinion that the current about Bonacca takes two different directions; one part setting to the N.W., and the other part branching to the S.S.W. I have found it so on several trials, which is the reason that I prefer taking a departure (for the bay) from the middle or East end of Rattan; for, if a ship take her departure from the West end, her course will be N.N.W.; but it very frequently happens that ships get down on those reefs when they take their departure from the West end. The reason is this—a ship steering N.W. from the West end has more of the current on her beam, which sweeps round the end of Rattan very strong at times; consequently, ships that take their departure from the East or middle part do not feel so much of the current."

(239.) **Bottles.**—*Caribbean Sea to Yucatan.*—A bottle from H.M.S. *Chanticleer*, in lat. 15° 29′, long. 76° 3′, at noon on the 23rd of February, 1831 (the ship being to the southward of Jamaica), was picked on the 20th of the next April upon the eastern coast of Yucatan, after having traversed over a distance of nearly 700 miles, at the rate of 28 miles per day.

Serranilla to Yucatan.—A bottle from a boat belonging to H.M. surveying-ship *Thunder*, at anchor under Serranilla West Kay, 10th of March, 1834, picked up at Half-Moon Kay, in the Bay of Honduras, on the 23rd of the next month, April; rate 10 miles per day.

Tobago to the Cayman.—A bottle from the American brig *Emma*, on her way from Philadelphia to Berbice, 17th of June, 1838, in lat. 11° 4′, long. 58° 50′, picked up on the 27th of the following August, upon the eastern shore of the Grand Cayman, 2,000 miles, at the rate of 28·6 miles per day.

Windward Channel, between Jamaica and Hayti.—A bottle from H.M.S. *Thunder*, in lat. 18° 56′, long. 74° 56′, 7th of April, 1839; current then setting S.W. by S. half a knot; picked up in the Grand Anse, near Jerimie (long. 7° 1′), on the 24th of the same month.

Hayti to Florida.—A bottle, some years ago, from the ship *Robert*, Captain Coulter, eastward of Alta Vela, on the South coast of Hayti; picked up about thirteen months afterward on the shore near St. Mary's, in Florida.

From bottles enumerated in Captain Becher's list: Ship *Race-horse*, Captain Home, thrown over in lat 12° 12′, long. 65° 50′, 17th April, 1836; picked up April 22nd, at Bonaire, 150 miles in 5 days. Ship *Chanticleer*, Captain Austen, thrown over February 23rd, 1831, in lat. 15° 30′, long. 76°; picked up on the East coast of Yucatan, April 30th, 680 miles in 56 days. H.M.S. *Thunder*, Capt. Barnett, thrown

over at Chagres, April 22nd, 1840; reached Belize, October 1st, 1840. H.M.S. *Thunder*, March 10th, 1834, started at Serranilla Bank; picked up near Belize, April 23rd, 575 miles in 44 days.

(240.) *On the northern coast of Hayti*, and in the windward passages, there does not appear to be any general current. On the North side of Cuba the case is nearly the same; but in the channel there is a regular tide throughout the year, subject, however, to certain variations.

The currents of the Caribbean Sea appear to be varied by the influence of the moon and change of seasons, and combine, in some degree, with the tides, especially about Cuba, Jamaica, and Hayti.

In the Bahama Passages the currents are devious; both weather and lee-current having been found. These, also, appear to be influenced by the tidal causes; for the tides are inoperative on the banks, and sometimes set strongly.

(241.) *Bahama Islands*, &c.—The following is extracted from Captain Maury's "Sailing Directions," 8th edition, vol. ii. Capt. W. C. Berry, says:—

"Having had long experience in the trade between New York and New Orleans, I herewith furnish you with a few remarks on winds and currents. For the last six years I have commanded the ship *Vicksburgh*, constantly trading between these two ports. In making the passage out, after passing the Hole-in-the-Wall, I have frequently found a current from one to three miles per hour, setting to the eastward through the N.W. channel of Providence, particularly after the wind has prevailed from the eastward a few days. This no doubt has been the cause of putting a number of vessels on shore among the Berry Islands. I have latterly made it a point to take the last bearings of the light on the Hole-in-the-Wall, and either haul up or keep off as I found the current; generally running on a West course until quite down with Little Stirrup Kays, then steering W. by N. $\frac{1}{2}$ N., by compass, if in the night, until I was up with the Great Isaacs. The last three voyages, having reached the vicinity of the Little Isaacs in the day time, I have hauled in on the bank between the western Little Isaacs and the East Brother Rock, and steered S.W. by W. by compass, which has brought me out in good passing distance from the Moselle Shoal. During one of my summer passages out, after passing the above shoal, I was compelled to anchor, and remained there for six days. The wind during all this time was light from the southward, and I could not help remarking the regularity of the current setting along the Bemini Islands, ebb and flow, about two miles per hour. This continues as far as Gun Kay, when close in, little or no current is experienced, except the ebb and flow, which is directly off the bank. In crossing the Santaren Channel, the current is governed greatly by the winds; with strong southerly winds the current sets about N.N.W., two miles per hour; on the other hand, with strong northerly winds, little or no current is felt. After leaving the Double-headed-Shot Kay, I have generally hauled over for Florida Reef, and in the day time kept close-in, when I have frequently found an eddy current setting to the westward from one to one and a half miles per hour. After passing the Tortugas, I have invariably felt a southerly current until I had reached the

longitude of 84° 30′ W., and even further than this at times, as will be seen by referring to my journals, particularly in November, 1848.

"Returning from New Orleans, I have always made it a point to keep to the westward until I had reached the longitude 85°, latitude 28°, before keeping off. My object in doing this is, that the wind here generally prevails from the northward and eastward, and that the current generally sets to the southward and eastward, which generally facilitates the passage. After rounding the Tortugas, with the wind from the eastward, I have generally beat down on the Florida side, knowing that the strongest current prevails on that shore, unless too close in. From Carysfort Reef to Matanilla, I have always endeavoured to keep in the middle of the stream. During all my voyages, I have made it a rule to steer N. by W. from Matanilla to latitude 22°, and then North to latitude 31°, before hauling up N.E. by N.; by so doing I have, with a few exceptions, kept the strongest current. On some other occasions, I have hauled up on a N.E. by N. course, when in latitude 30°, longitude 79° 40′, and have soon found myself on the eastern edge of the gulf. After rounding Cape Hatteras, it is advisable to keep to the westward, especially in the winter season, on account of the prevailing westerly winds."

(242.) The following is an additional detail of the best information we have been able to collect of the currents in the Caribbean and Mexican Seas, from the *Derrotero de las Antillas, &c.*

In the Channel between Trinidad and Grenada, the current has been found to set nearly West; on the South side half a point southerly, and on the North side half a point northerly. Its velocity from 1 mile to 1½ and 2 miles per hour.

Between Grenada and St. Vincent's, among the Grenadines, the currents are devious; but the general inset appears to be W. by N.

Between St. Vincent's and St. Lucio the current, from the eastward, sets in more northerly; and within, on the West, it has been found setting to the N.W. Between these islands it seems to be as strong as in any other part of the range.

Between St. Lucia and Martinique it has been found nearly North. Very variable on the western side of the latter.

The current sets nearly in the same manner *between Martinique and Dominica. Northward of Guadaloupe*, it sets W. ½ S.; and between *Montserrat and Antigua*, N.W.

At the distance of about 1°, *within the range of the Caribbee Islands*, and to the Virgin Islands, the current has been found setting, in general, to the W.N.W. from 1 to 1½ miles an hour.*

In the *Mona Passage*, between Porto Rico and Hayti, the current has been marked as frequently setting to the N.W., and we have instances of a set through to the S.W.; but Captain Monteath, in February, 1816, when proceeding southward toward Porto Rico, in from lat. 23½ to 22°, long. 64° to

* On the leeward side of the Virgin Isles devious currents are found, frequently to the south-eastward. The same have been observed on the western side of St. Christopher's, &c.

65°, found the current setting N.N.E. at the rate of 20 miles in the twenty-four hours; and he says, that off the N.W. point of Porto Rico it invariably sets from the Caribbean Sea to the North and N.N.E. On the western side of the passage it set North, 2 miles an hour; but there have been instances of an inset from the N.W.

From Trinidad, westward, and off the North side of the Spanish Leeward Isles, the current has been found setting West and S.W. to the Gulf of Maracaybo; thence S.W. also to Cartagena; but it varies, as already described.

From Cartagena toward the *Channel of Yucatan* it has been found N.N.W.. N.W., W.N.W., and N.W. by N., from 1 to nearly 2 miles, and then decreasing to 1½ mile per hour. It has also been found setting to the eastward, as shown in the present pages.

(243.) **Counter Currents.**—From the foregoing it will be seen that the great drift which, passing from the Atlantic through the Cribbean Sea into the Gulf of Mexico to feed the Gulf Stream, is not nearly so constant nor so strong as might be argued, *à priori,* from the apparent magnitude of that mighty current. Not only is it inconstant even in the mid-channel, but it is diverted by local causes and land configurations into opposite directions, as is shown to be the case in the great Bays of Guatemala and Honduras, as described below.

Upon referring to the description of the Guinea or Equatorial counter-current, as recited in pages 339 to 347, it is shown that it extends much farther to the westward, during the period when the sun is in northern signs, than had been before attributed to it. The western extension of the Guinea Current, coincident with the increase of the belt of equatorial calms (58), page 217, and (65), page 222, may owe its origin to the same causes, hitherto almost unexplained, as that to which this uncertainty of the great westerly drift across the Caribbean Sea is owing.

Whether it is owing to the influence of tide, the effect of distant and local winds, or of temperature, or of some hitherto unexplained effect of the earth's rotation, has yet to be argued. It is probable that hereafter a systematic examination of these apparently contradictory phenomena will lead to some important conclusions in the general subject of meteorology.

(244.) In the *Bays of Guatemala* and *Honduras,* as above said, the currents are frequently found to be running rapidly from *West to East,* especially near the shores. This counter-current is seldom encountered outside the lines which join their outer points. From Cape la Vela, or northward of the Gulf of Venezuela, the current generally sets to the N.W. toward the Channel of Yucatan, as has been before remarked.

"In the space between Cape Gracias a Dios and Cape de la Vela offshoots and eddies from the great equatorial current are found. This assertion is not merely grounded on those of former navigators, or on the examination of the coast outline, but on actual experience.—(Capt. W. S. Smith, R.N., H.M.S. *Larne,* 1833.)

"A writer, worthy of great respect, Captain Mackellar, R.N., has stated —'The current between the island of Jamaica and the Spanish main, or coast of Colombia, is not always to be depended upon as setting to the westward, as is generally supposed; for, in crossing from Jamaica to the main,

ships have been known to be driven to the eastward by the current.' This circumstance must be of rare occurrence at the northern part of the passage, and is here mentioned to make known its possibility. I myself have made runs across between Jamaica and the opposite main at many times and seasons, and am, therefore, governed by practice as well as theory in the following remarks.

1st. *Local current between the South side Jamaica, the Morant Kays, and Pedro Shoals.*—This is very uncertain, both in rate and direction. Its rate may be from 0 to 1½ knot per hour; and its direction, either North, East, or West, according to existing circumstances.

At the Morant Kays, the current is known to be variable. Over the Pedro Shoals it is supposed almost ever to run in a westerly direction. Between these two dangers, therefore, it behoves a ship at night to be full of precaution, and not to rely on the continuance of any current she may have ascertained, when either to the northward or southward of her then situation.

2nd. *Current southward of the Morant Kays and Pedro Bank,* or between the parallels of 17° and 15°. This current runs, perhaps always, true West to N.W. by W. from 20 to 55 miles per day.

Among the Musquito Shoals the currents are equally strong and more uncertain. Between latitude 15° and a line extending from Cape de la Vela and Cape Gracias a Dios, including some of the Mosquito Kays, the direction is W.S.W. to N.W. 20 to 40 miles per day.

3. *Southward of the imaginary line between the Capes de la Vela and Gracias a Dios* and to the distance of 30 miles from the coast, the sets are so very variable as to baffle all system. Sometimes no current whatever is felt; at other periods it may run North, South, East, or West, 35 miles a day. Let it be borne in mind, however, that their direction is very seldom toward the *East,* but generally toward the *West.* St. Andrew's Isle and the frontier rocks of the Mosquito Bank are equally beset by changeable currents, of velocities amounting to *fifty* miles a day.

4. *Inshore or Land Current,* between Cape Manzanillo, near Porto Bello and San Juan de Nicaragua. This current sets from *westward to eastward.* It is an eddy, striking out from the Caribbean Current at Cape Gracias a Dios, and eventually returning into it, with a broken and divided force, to the North of Cartagena. The breadth of this current extends from the land to a distance of about 30 miles in the offing. Its rate is from one to two knots, and its direction parallel to the curvature of the coast and capes.

The streams out of numerous rivers, entering this current, seems to increase its rapidity; for close in shore, between the rivers, the rate is seldom less than 2 knots; at 6 miles off the land it runs about 1 knot; and at a greater distance the same.

(245.) From *Cape Antonio* the current sets, *at times,* to the E.S.E., past the Isle of Pines. Capt. Livingston has informed us that, in March, 1818, he found that current between the Great Cayman and Isle of Pines to set in that direction, at the rate of fully 2½ miles an hour, or 60 miles in the 24 hours. In August, 1817, he found the set nearly the same, but the current not half so strong. The "Spanish Directory" says:—"From Cape de Cruz, on the South side of Cuba, it is noticed that there is a *constant current to the*

westward, with some inclination to the southward or northward, and which has been known sometimes to set 20 miles in a single day." In opposition to this the exact words of Capt. Livingston are—"I have twice experienced a strong current, setting about E.S.E., between the Caymans and Isle of Pines; and on the latter of these occasions both my mate and myself separately calculated it to set about 60 miles per day, or 2½ miles per hour. This, however, I incline to think a very particular case, such as may but seldom occur. The winds at this time were light and westerly. On the other occasion, so far as I recollect, it set about 12 or 14 miles per day only. All my papers on these subjects have been lost; but the first instance was too remarkable to be forgotten."

(246.) A further evidence of this is given by Captain Harry Miles, ship *Illustrious*. 1858, December 29th, in rounding Cape Antonio (West of Cuba) I could not detect any current. At times I have found it strong to S.E.

1859, April 16th, noon, lat. 25° 36′ N., long. 83° 33′ W., at 8 p.m. sounded in 38, 35, 33, and 32 fathoms, bottom at first depth coarse white sand, with broken shells, and gradually becoming of a greenish hue as the water shoaled. The wind being shy from S.W. I anxiously anticipated the current which Blunt assures us "runs lively to southward along the edge of Tortugas soundings," in lieu of which, by a series of first-class observations, verified on making Bush Kay Light, I ascertained the set N.N.E. 1¼ mile per hour since striking soundings. In fact, coupled with former experience, I am convinced that, although during the influence of northerly and easterly winds, a S.E. current of considerable strength most certainly exists, yet with a southerly breeze it is not only neutralized, but, as in the present instance, may set in a contrary direction, or to N.E.

(247.) Off the South side of Cuba the current has frequently been found setting to the eastward when the moon is increasing, or in her first two quarters; and thus it continues from Cape Antonio to Cape Maize. It is represented that it runs to the eastward for a fortnight, and then to the westward about the same time. Coasters from the Caymans commonly take the advantage of the easterly current for making their passage to Jamaica.

From this information we may conjecture that the current, which has been described as setting to the E.S.E. from Cape Antonio to Cape Maysi, is not *permanent*, but, at times, on the contrary, imperceptible, according to the age of the moon; and this has, we believe, been verified, in several instances, while the cause has remained unknown.

Captain Manderson had stated, that when a strong easterly wind has been blowing between Cuba and Florida, vessels heaving-to off the South side of Cape Antonio, at about 2 leagues from the shore, have, in the course of one night, been carried against a strong sea breeze, nearly as high as Cape Corrientes, being a distance of 10 leagues. Our friend Captain Rowland Bourke, when once lying-to in the *Archibald*, for the night, off Cape Antonio, found himself, next morning, off Cape Corrientes.

Capt. Dunsterville has said, "I am firmly established in an opinion, from twelve years' observation, that not only are the winds and the weather on the West India station influenced by the change of the moon, but the cur-

rents also; and it is frequently found that, if the waters run to the eastward, it is at the change and full of the moon."

On this subject Captain Livingston says, "It is a prevailing opinion with many, that the moon governs entirely the currents among the West India Islands. No doubt the moon has some effect on them, but the winds have a still more powerful influence.

"It is rarely, indeed, on the North side of the island of Jamaica that there is a westerly current when the North and N.W. wind prevail; the current then always, or almost always, setting to the eastward.

"On the South side of Cuba, when the wind is westerly, which it often is, you are always certain of a reflowing current round Cape Antonio. This is easily accounted for; as when the fresh trade-wind ceases, and the westerly wind sets in, the barrier is, in some degree, removed, which confined the waters in the Mexican Sea, and they seek to regain their level as well by the channel of Yucatan as by the Strait of Florida."

Between the Isles of Pines and main land of Cuba is a strong north-easterly indraught, generally running from 1 to 1½ miles an hour, and which has caused the loss of many vessels on St. Felipe Kays and the dangerous bank stretching therefrom to the westward.

In the Windward Channel of Jamaica, the current generally sets with the wind to leeward or S.W.; yet both here and at Jamaica it is variable. Some have affirmed that, when a current runs to leeward, on the South side of Jamaica, there is frequently one setting eastward on the North side; and, at other times, no current is to be perceived; also that, when a lee current runs on the North shore, the same circumstances may be perceived on the South shore as were before observed on the North.

(248.) **Channel of Yucatan.**—The principal entrance from the Caribbean Sea into the Gulf of Mexico is 110 miles in width, between Cape Antonio, marked by its fine lighthouse, and Cape Catoche, the N.E. point of Yucatan. The current most usually sets with considerable rapidity to the northward through it.

According to the calculation of all attainable observations derived from Major Rennel, Commander Maury, &c., the following is the mean rate of the current in the various months:—January, 33 miles per day; February, 34 miles per day; March, 36 miles; April, 33 miles; May, 17 miles; June, 26 miles; July, 29 miles; August, 31 miles; September, 30 miles; October, 38 miles; November, 36 miles; December, 48 miles per day. The annual mean of all these observations is 32·7 miles per day. From the monthly results given in the charts drawn up by the Meteorological Office, 1872, this annual mean is given as 33·9 miles (or 30·76 miles) per day. These velocities are much inferior to what might be supposed from the magnitude of the outset of the Gulf Stream as formerly calculated, but this, as will be seen presently, has been over-stated.

(249.) **Gulf of Mexico.**—The Mexican Sea appears to be the receptacle and terminus of all the waters flowing westward, and although we are not perfectly acquainted with all the features of the current, yet sufficient is known to warrant the affirmation, that the current through the Yucatan Channel diverging to eastward and westward, the western branch circulates around the whole of the shores of the Gulf to westward and northward, and

thence flowing eastward and south-eastward joins the eastern, and perhaps principal, branch of the Yucatan current, forming the mighty Gulf Stream.

On the chart of the North Atlantic, before mentioned, all the observations attainable having been integrated, and it plainly shows that the circulation stated above does exist, and that it follows the main trends of the coasts of Yucatan and Mexico, and thence along the coast of Texas, at rates varying from 14 to 31 miles per day.

(250.) The mean temperature of the water of the Gulf of Mexico is probably as high as any part of the ocean, from several manifest causes, and hence it is, in the bed of this sea, that those nurseries of the Sargasso weed exist (206), which, torn from their habitat by the force of the current, &c., are drifted into that great central area of the Atlantic, to which they give the characteristic peculiarity.

It is also probable that animal life is peculiar and abundant in these tepid waters. "The phosphorescent lights observed in the Mexican Sea shine with greater brilliancy (April) than I had noticed elsewhere; some of these were very large, and flashed like the priming of a gun, sometimes at a long distance from the ship. I observed that the little shining spiracles were confined to the sides of the vessel and her wake, and that the waves, when they broke into foam, did not (as in other parts of the ocean) sparkle.

"The colour of the water in the Sea of Mexico is of a dark indigo, darker or more intense than that of the ocean generally; the colour of the sea in the Florida Channel is a fine blue, not so dark as that of the Sea of Mexico, or of the ocean generally. Phosphorescent lights are equally abundant in the Florida Stream, some unusually large and brilliant; and some of the small lights appeared to spring out of the water with a sweep motion, which I had never before observed; the temperature of the water was 79°, that of the air 76°."—J. E.

(251.) The following exemplification of the currents of the Mexican Gulf is taken from the eighth edition of Maury's "Sailing Directions," vol. ii., p. 17:—

There is a constant set from the Caribbean Sea into the Mexican Gulf to form the Gulf Stream. Vessels passing up to the northward may take advantage of it. It is bifurcated just after entering the Gulf. The bottle paper of the *Hermes* followed this Yucatan current to the "fork," and then took the western branch.

"H.M.S. *Hermes*, 15th April, 1858, lat. 17° 59′ N., long. 78° 50′ W., H. Congton, commander, J. E. Solfleet, master. This bottle thrown over at the West end of Jamaica, was found on the South side of Padre Island, lat. 26° 5′ N., long. 97° 10′ W., Aug. 23, 1857, and forwarded by Mr. J. R. Baker, who says, 'The drift shown by the course of this bottle confirms my own observations since I have been here, viz., that the current divides between Cape Antonio and Cape Catoche, the western part of it keeps a westerly course until it reaches this coast between San Fernandino on the coast of Mexico, from Corpus Christi on Texas, where it meets the south-westerly current from the coast of Florida and Louisiana. And it is strange to remark the mixture of floating objects thrown on the beach of this coast by the meeting of the currents. Flat boats, oars, saw-logs, clap-boards, old skiffs, &c., from the Mississipi, mixed up with branches of the

mangrove, mahogany, bay cedar, young cocoa-nuts, canoe paddles of mahogany, &c., from the Caribbean Sea and Coast of Honduras.'

"It may be remarked on this that the easterly winds may have something to do with the westerly drift from the Mississippi of objects which float high out of the waters.

"Another bottle, from the ship *Admiral*, S. Picken, commander, thrown over on the Equator, long. 30° W., 17th February, 1856, came ashore at Aransas Pass, Texas, October 24th, 1856, 250 days afterwards, having drifted 4,300 miles, or 16 miles per day."

(252.) It is difficult to define the separation between the currents which pass eastward and westward to the North of the Yucatan Channel. It is certain that they set with considerable velocity to the southward and south-eastward over the Tortugas Bank, and also to the S.E. from the Mississippi. Perhaps a line might be drawn from the centre of the strait to the mouth of the Mississippi, to the West of which it will usually be found that the streams have westing in them, and to the East of it that they set towards the Gulf of Florida.

In the strait between Cuba and the Florida Reefs, that great stream which is described in the next section, has really its commencement.

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7. THE GULF STREAM.

(253.) The Florida or Gulf Stream has received more attention—has been the subject of more speculation—and has served as the basis of more theories than all the other currents of the ocean collectively. Although modern research, conducted with all refinement, in contradistinction to the imperfect observation of the passing seaman in former years, has shorn it of much of the grandeur and magnitude it has formerly been invested with, still it is a mighty and majestic current, well worthy of all the laborious investigation which the philosopher or mariner have bestowed upon it.

The investigations which the United States Government surveyors have carried on in the narrower portion at the commencement of the stream, have dissipated all preconceived notions of its enormous magnitude; and these were only commenced in 1855, and when subsequently published they were so startling as to be received almost with incredulity. But the subsequent most careful measurement of its depth, velocity, temperature, and other collateral features in many parts, down to 1866, have entirely confirmed this first statement, made by Commander Craven, in 1855, that the narrowest was the *shallowest* part of its course. From these and from the other numerous sections which have been examined on lines transverse to its course between Florida and Nantucket, we are enabled to calculate with some approach to exactness, what is the amount, rate, and temperature of the volume of water which is transported by it into colder latitudes. The

sections of the stream to N.E. of the Narrows were examined between 1845 and 1854.

(254.) It may seem, therefore, somewhat surprising, that—in the face of its now known much smaller volume and much slower rate of travelling, and also of the well-ascertained interferences it has to encounter—a much more extended area should be claimed to be under its influence, than what was considered when very much less was known of its real character. When Major Rennell's "Investigation" was published in 1832, and which contained a digest of all that was known, the conclusion was arrived at, "that as a *current*, it may be said to terminate at ordinary times at the western side of the Azores," and this is the sum of all the arguments subsequently used, with the exception, that Dr. Franklin, in November, 1776, on approaching the European coast, was never out of the warm water of the Gulf Stream; and that General Sabine, in 1822, also crossed its warmer waters.

It is only since the accession of our *exact* knowledge of the Gulf Stream proper, or that between Florida and the Newfoundland Banks, that the argument has been exalted—that it is the Gulf Stream, which, after traversing the intervening space of the Atlantic, transports the amenity of climate over the whole of the north-western shores of Europe, but also in entering the outer basin past and around Spitzbergen, it keeps an open sea there, and by its warmth maintains a constant circulation around the North Pole.

(255.) It was during active researches in the Arctic regions, when the progress and fate of Sir John Franklin and Captain Crozier, with their ship's crews, were involved in such profound security, that it was claimed for the Gulf Stream to have volume and power sufficient to have vast influence in ameliorating the Arctic climate. The failure of every attempt to penetrate the mystery which had been so zealously directed towards the channels West of Baffin's Bay prior to 1851—1852, led Dr. Augustus Petermann to examine into the possibility of reaching the neighbourhood of Behrings Strait by the way of Spitzbergen and Novaya Zemlia, and the elaborate and most useful investigations he then carried on led him to the conclusion that the varied phenomena he then eliminated, the abundance of animal life, the temperature of sea and climate, and features in almost every department of physics, could only be attributed to a warm north-easterly current, which he considered was an extension of the Gulf Stream.*

(256.) To this last conclusion we still firmly demur, as has been done in previous editions of this book, and this expression may be taken as a recantation of those ideas which obtained before we were made acquainted with the true dimensions of the Gulf Stream proper.† In saying this it must be

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* See Parliamentary papers on the Arctic expeditions; Further Correspondence, &c., 1852, pp. 142, et seq.; also Journal of the Royal Geographical Society, xxii., p. 118—128, on the Distribution of Animal Life in the Arctic Regions, by A. Petermann, F.R.G.S.

† See Proceedings of the Royal Geographical Society, vol. xiii., 1868-9, pp. 102—112; On the Gulf Stream," by A. G. Findlay; and the Journal of the Royal United Service Institution, vol, xiv., 1870.

distinctly understood that the effects claimed for it on the eastern side of the Atlantic are not for a moment questioned. There can be no difference of opinion as to the facts which Dr. Petermann and many others bring forward in the elaborate memoir which he published.* It is rather a question of nomenclature, for the connection between these phenomena and the Gulf Stream proper is not shown.

The facts are incontrovertible, but it is strongly affirmed that these effects cannot be produced or effected by the Gulf Stream as now known, or by any fluctuations in its character. A very much wider field of action must be brought to bear on the subject; and it is contended that this north-easterly drift, or indraught along the Scandinavian coast, should have a distinct name, as being an independent current, having its origin somewhere between the coast of Europe and the Great Banks, and propelled northward by the S.W. winds which prevail throughout the year on this side of the Atlantic, or by some greater cause. But in thus stating the case it must be qualified in a degree by the fact that the Gulf water forms a small part of this current, which is so cooled down and intermingled with the Arctic current, that if any direct connection does exist, it is with both of these currents, and that, perhaps, in an equal degree.

(257.) In the preceding pages we have traced the course of the waters from the shores of Europe down to the great set or tropical drift, and thence through the Channel of Yucatan to the entrance of the narrow channel between the North shore of Cuba and the Florida Cays. Here may be said to be the commencement of the Gulf Stream as an independent current, as it flows swiftly hence to the eastward in opposition to its previous course, and then northward through the Narrows between Cape Florida and the Bemini Isles. Keeping this direction with its high velocity and temperature, it is deflected to the N.E. by the form of the American coast, and assuming a more easterly direction, and gradually spreading its warmer waters over a broader area through an immense region of perpetual fogs rising from its tepid waters, it pursues its course with a gradually decreasing rate and temperature, until it reaches the southern part of the banks of Newfoundland. At this part it encounters the Arctic Current, which, crossing its track and importing into it the influences of an arctic temperature, and the counteracting effects of an adverse current upon its diminished force and much decreased volume, it ceases to maintain its character as a Gulf Stream or an independent current.

(258.) **History.**—The Gulf Stream was known by its present name, and in its now known form, from very early times. The northern equatorial drift was noticed by Columbus, September 13, 1492, when in lat. 27° N., long. 40° W., and this is the first ocean current observation. In the subsequent voyages, in 1502-3, he observed the strength of the streams in the Caribbean Sea. The first voyage through the Gulf of Florida was that by Poncé de Leon, in 1512 or 1513, and this gave the first account of the

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* See Geographische Mittheilungen, Gotha, Justus Perthes, vol. xvi., 1870, part 6 and 7. This most valuable essay, with smple references, has been translated for the U.S. Hydrographic Office.

stream itself, and he named the present Cape Canaveral *el Cabo de Corrientes*, from the circumstance. Several other Spanish voyagers, about this period, also experienced its effects, especially the pilot Antonio de Alaminos, who sailed through it in 1519. In Mr. Kohl's exhaustive and most interesting Monograph,* these and very many other earlier voyages are noticed, and the whole history of the subject from the earliest to the latest days are dilated on.

(259.) That excellent observer, William Dampier, in his "Discourses on the Trade Winds," &c., published in 1690, page 105, gives the following observations:—

"And 'tis as probable that the current, which sets to leeward on all the coast from *Cape St. Augustine* to *Cape Catoch*, never enters the *Bay of Mexico*, but bends still to the northward, till 'tis checked by the *Florida* shore; and then wheels about to the East, till it comes nearer the Gulph's Mouth, and there joining with the soaking current that draws down on the North sides of *Hispaniola* and *Cuba*, passes altogether with great strength through the Gulph of Florida, which is the most remarkable Gulph in the World for its Currents, because it always sets very strong to the North. Yet near the shores on each side this Gulph there are tides, especially on the *Florida* shore; and Ships may pass which way they please, if they are acquainted.

"It has formerly been accounted very dangerous to meet with a North in this Gulph; and for that reason our *Jamaica* ships, to avoid them, have rather chosen to go to the Eastward and pass through the *Cacuses* (Cayeos) in the season that Norths do blow. The *Cacuses* are sands that lie off the N.W. end of *Hispaniola*. Those that went from *Port Royal* in *Jamaica* had good reason for this; for if a North took them at their going out, it would help them forward in their way, which, should they have been going towards the Gulph, it would obstruct them. Then besides, if a North take a ship in the Gulph, the wind blowing against the Current makes an extraordinary Sea, and so thick come the Waves one after another that a ship can't possibly live in it, yet of late they go through at all times of the Year, and if a North takes them in the Gulph, they put away right before the Wind and Sea, with a small head sail; yet the Current is then as strong or stronger than at other times, and forces them back, stern foremost against both Wind and Sea; for though the surface of the Sea is raised in Waves and driven violently with the Winds to the southward, yet the Current underneath runs still to the Northward; neither is it any strange thing to see two different Currents at one place and time, the superficial Water running one way, and that underneath running quite contrary; for sometimes at an anchor, I have seen the Cable carryed thus by two different Streams, the under part having been doubled one way, and the upper part the contrary."

It is, therefore, somewhat surprising that a claim should of late years have been made for Dr. Franklin as the real discoverer of its nature and its warmth in 1770. The tale is this:—Being in London in that year, he was

* Geschichte des Golfstroms und seiner Erforschung, &c. Eine Monographie. J. G. Kohl. Bremen, 1868.

consulted by the Treasury as to why the Falmouth packets were generally a fortnight longer to New York than common traders were from London to Providence, Rhode Island? He therefore consulted a Nantucket whaler, who explained that the Rhode Island captains, being acquainted with the Gulf Stream, avoided it, while the Falmouth commanders, being ignorant of it, were set back 60 or 70 (!!) miles a day by it. The Nantucket captain laid its course on a chart, which is also stated to have been followed almost without an alteration. Without stopping to refute this altogether, which may be done by Dampier and his predecessors, it will be evident that something else than the Gulf Stream must have retarded them 60 or 70 miles a day in that latitude, if they were thus delayed.

(260.) **Causes.**—There have been very many speculations as to the cause of this great stream, but they have been promulgated before any increase of knowledge upon which to found arguments, and, as has been said above, recent investigations have overturned most of those which have been advanced. It has been supposed that it runs out of the Gulf of Mexico from the superior level of that sea, but facts are wanting for such an assumption. Capt. Manderson, R.N., promulgated an opinion in his "Examination as to the true course of the Florida Stream," that it was owing to the Mississippi and the floods from the other rivers falling into the Gulf of Mexico. It was still further argued that the velocity of the Gulf Stream might be determined by the flood from these rivers. But Captain Andrew Livingston, in our former editions, overturned this hypothesis by showing that what is poured into the sea by the River Mississippi is not a three-thousandth part of the volume of the Gulf Stream. He thought that it might be accounted for by the motion of the sun in the ecliptic, and its influence on the Atlantic waters.

The effects of temperature is also advanced as the prime mover, by increasing the heat of the water it expands, and thus becomes higher than the cooler waters beyond it, and as the Gulf of Mexico has the highest temperature, here is the head water of the Gulf Stream on that account. Sir John Herschel says on this point:—"Let us see what this declivity, formed by unequal temperature, would amount to. The equatorial surface-water has a temperature of 84°; at 7,200 ft. the temperature is 39°, the level of which temperature rises to the surface in lat. 56°. Taking the dilatability of sea-water to be the same as fresh, a uniform increase of temperature from 39° to 84° would dilate a column of 7,200 ft. by 10 ft. (or 9,971 ft. more exactly), at which height, therefore, above the spheroid of equilibrium (or above the sea level in 56°), the equatorial surface is actually raised by this dilatation. An arc of 56° on the earth's surface is 3,360 geographical miles, so that (were the water to run direct North) we have a slope of 1-28th of an inch per mile for the water so raised to run down. As the accelerating form, corresponding to such a slope (of 1-10th of a second, 0.1″ of arc) is less than the two-millionth part of gravity, we may dismiss this as a cause capable of creating only a very trifling surface drift, even were it the proper direction to form, by concentration, a current from East to West; *which it would not be, but the very reverse.*"

Evaporation has been assumed as another cause, but it can be shown that the lines of maximum evaporation are near the tropics, that is, near to the

point where the Gulf Stream removes and flows away from, instead of running towards, if this be taken as a sole cause. But the line of greatest precipitation is near the equator, and therefore the surface water of the ocean is there lighter, or of less specific gravity than under the evaporating tropical influences; this source of instability will cause the waters to flow directly towards this line, throughout the whole circuit, and not in the form of a partial stream. Besides this, it may be shown by the few experiments hitherto recorded, that the density of sea-water, at some fathoms below the surface, is very nearly the same all over the ocean, so that surface experiments afford but imperfect data, upon which little or nothing can be grounded in our present state of knowledge.

(261.) There have been so many objections raised to the plain fact that the trade and anti-trade wind will account for many or most of the phenomena of oceanic circulation, that it would be far too discursive for a practical work to enter into such a field of speculation. As has been stated before, (2) 173, the winds and water of the Atlantic seem to follow much the same law, as far as their different natures will allow, that is, they circulate more or less around a central axis or area—the calms of Cancer in the one case, and the Sargasso Sea in the other. All further theory must be sought for in those works which deal with speculative science.

Captain Maury has adduced arguments against the theory of assuming the trade winds as the prime cause of the Gulf Stream, in opposition to the line of reasoning followed by Sir John Herschel. He has drawn up several tables to show that the S.E. trades have a greater preponderating force over the N.E. trades in the Atlantic, but he proceeds on the assumption that the *equator is the division* between the two systems. This basis, which he elsewhere disproves, will very inadequately explain the relative force and duration of two trade winds, as is shown in (35), on page 195. In fact from arguing in this way, he endeavours to prove, that from the much greater force (nearly twice) of the southern trades, from their much greater constancy, and still further, that from the greater preponderance of *westerly* winds within the tropics, on the North side of the equator, *that the North-East Trade Wind scarcely blows at all in the North Atlantic.* A position which is disproved by his pilot charts, and by the experience of all sailors. It need scarcely be argued against that the S.E. trades have *quadruple* the force, and nearly *double* the duration of the N.E. trades, making them *eight* times as important.

But besides this, the wind and current charts demonstrate that the S.E. trades, and their consequent drift, are almost always felt throughout nearly the whole year, to the *North* of the equator, and in fact send a large proportion of the water into the Caribbean Sea (11), page 178. The trade-winds may therefore be held to be a great cause of the Gulf Stream.

(262.) In the previous pages, describing the equatorial currents, it was shown (216), (230), pp. 355 to 364, that the united stream of the northern equatorial drift and the much more powerful stream from the South equatorial regions, when passing Cape San Roque and the northern coast of Brasil, have a breadth of not less than 2,000 to 2,200 miles, and these flow with a velocity varying at times from 60 to 80 miles per day in the southern part, to 10 or 15 miles in the northern part of the drift. The streams thus

combined impinge on the eastern faces of the line of the Caribbee Islands, and what slight drift may pass westward to the northward of Porto Rio and and the Bahama Islands, does not reach the Gulf Stream, but forms, apparently, a recurving current to the S.E. along the north-eastern side of the Archipelago. This equatorial stream, which has a mean annual temperature of 77.6° (varying between 72.5° and 81.4°) on the eastern or African side, and increasing to 80.6° (from 79.7° to 84.2°) on the American side, covers an area of not less than 5,400,000 square geographical miles of tropically heated water. The whole of this moving surface impinges on the eastern face of the Caribbee Islands, and here another difficulty awaits us. The line of islands diminish the water way by one half, so that theoretically the stream should rush through the openings between the islands with redoubled velocity, but no such phenomena occurs. The currents through the Archipelago are constant but not more violent than in the ocean to the East of them. One half of this great drift therefore appears to die out on reaching the obstacle,* and no clue has as yet been given to its extinction, but it shows one thing, that the movement must be very superficial or it would be impossible for a great body of water to be thus quietly arrested. The only outlet it appears to have is the comparatively puny Gulf Stream with a breadth of not more than one six-hundredth part of the parent source. Moreover, as has been shown on pages 376 to 381 (243) to (251), that it has not sufficient power in the Caribbean Sea to maintain a persistent westwardly course, but that it is liable to frequent interruptions and is sometimes even reversed.

The whole subject is fraught with many difficulties.

(263.) The Gulf Stream has had from very early times a very bad reputation among ship-masters for its dangerous character, and the hundreds of wrecks and millions of property which have bestrewed its margin have given good occasion for such a character. For not only is it to be dreaded for its stormy character, but also its violent stream renders a ship quite unmanageable during a calm. At these times should hazy weather occur, and the sameness of the shores mislead the stranger, he is open to many difficulties and dangers. But the excellent system of beaconage along the Florida Reefs, as presently described, and the important lights which direct by night, have very much reduced its bad character, and diminished the employment of that enterprising race, the wreckers of Kay West and the Florida Reefs.

(264.) **Characteristics.**—The *indications of the stream* are the *appearance* and the *temperature of the water*. The stream, in its lower latitudes and usual course, where it flows uninterrupted, may be known in fair weather by its smooth and clear blue surface; for, without the line formed by a ripple on its edge, the water in some places appears like boiling water of a blue colour; and, in other places, it foams like the waters of a cataract, even in dead calms, and in deep water.

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* There is an exactly analogous case in the abrupt termination to the Guinea current in the Bight of Biafra. It is traced up to the coast itself, and with a mean rate of 15 or 16 miles per day, and then disappears; it does not apparently unite with the South African current setting to the northward.

On the outer edge of the stream, especially in fair weather, there are great ripplings, which are very perceptible. The appearance of the sea-weed, by day, is an indication of this edge of the stream; this weed being, *commonly*, on the edge without the stream, in greater quantity and larger clusters than within it.

It has been said that the water within the stream does not sparkle in the night. We are assured by Captain Livingston that, though this a common, it is a misconceived, idea. "I have frequently seen it sparkle much; even last night it sparkled considerably, when we were in about 25° N., and 80° or 79° 40′ W.; and off Cape Roman, Cape Fear, Cape Hatteras, and the entrance of the Delaware, I have seen the water sparkle pretty much, though I think not equal to what it does in many other parts of the ocean." —*In the Stream*, 10th of September, 1818. *A. L.*

Mr. Ellicott has said (Journal, 1803):—It has been mentioned by Dr. Franklin, that the water of the Gulf Stream *does not sparkle in the night.* This, so far as my observations go, is incorrect: I saw but little or no difference between that and the other water on the coast; but, if there was any, that of the Gulf Stream was the most sparkling and luminous. It may, however, be observed, that the same water is very different, at different times, in this respect.

"The same ingenious writer and philosopher likewise observes, that the gulf-weed is a sign of being in the stream. This is in part true, but by no means to be considered as a general rule, because *the water on the borders of the stream is constantly mixing with the adjoining water, and leaving some of the weed behind*, which consequently falls into the eddy currents, and is carried off many leagues.

(265.) **Extent.**—The Gulf Stream commences its great career between the Tortugas Bank and the coast of Cuba, therefore the line joining the Dry Tortugas and Havana may be taken as its starting point. It is here 95 miles wide. At the channel between the Kay Sal Bank and Sombrero Kay it is only 48 miles wide; off Cape Florida, its narrowest and shallowest part, it is 45 miles. Between the edge of soundings off Jupiter Inlet and the Mantanilla Reefs it is 50 miles. This part of the Gulf Stream, which confines it, before it shoots off uncontrolled into the Atlantic is 330 miles long.

Pursuing its way northward, its warmest waters and strongest current keeps near to the edge of the bank of soundings which fronts the coasts of Georgia and the Carolinas, following the general curve very strictly, and in its main strength keeping 50 miles off Cape Hatteras, where the whole breadth occupied by the three or more warm bands is included in a breadth of 200 miles, the breadth of the bands themselves may not be more than 120 miles. This portion of its course from the channel within the Matanilla is about 590 miles further.

To the northward of this, its N.W. edge still follows the edge of the banks of soundings, and being diverted more to the East by the obstacles lying off it, gradually winds more to the eastward towards the parallel of 40°, to a line transverse to its course trending S.E. from Cape Cod, which will be about 430 or 450 miles beyond the Cape Hatteras section. It is here from 250 to 300 miles broad. Beyond this it pursues an easterly course for

1,250 miles to the meridian of 40° W., which is 350 miles East of the Great Newfoundland Bank, and skirting the southern edge of the Grand Banks of Newfoundland, it proceeds with diminished velocity and temperature to about the meridian of 40° West just named, when its further drift to the eastward cannot be distinguished from that of the whole surface of the ocean to the North and South of it. The total distance we have thus gone over will be about 3,500 miles, throughout the whole of which its characteristics may be distinctly traced, although its lateral boundaries are not so easily defined.

It has been usual to extend its independent existence some 1,200 or 1,500 miles further to the shores of Western Europe, as before stated, but when its volume in the outset, or in its *narrowest* part, is considered, it will be no great sacrifice of previously formed opinions to curtail it of its more extended features.

(266.) Throughout its latter course its left-hand margin carries the greatest strength. In the Gulf of Florida its southern side is the most powerful. Northward of the gulf its eastern and south-eastern side is difficult to define, as it is found that the Gulf Stream may be said to consist of several longitudinal bands of water, as presently described. To the southward of British North America its force gradually disappears till it is lost in the central still water of the Sargasso Sea. The diagram of the currents which elucidates this section will give a clearer idea of its relation to the great circulatory system, than any long description can do.

(267). **Depth.**—Deep-sea sounding has of late years been conducted with such precision and certainty that any doubts which were formerly held on this topic must be abandoned. It is true that the labour and appliances can only be at the command of Government vessels in their extended use; but the United States' Government officers have done well to maintain their national honour in their endeavours to elucidate their famous current.

We are now made intimate with the former hidden mysteries of the commencement of the Gulf Stream, through the observations conducted by the United States' Coast Survey between 1855 and 1859. In the first named year, Lieutenant-Commander Craven obtained soundings and temperatures along the bottom of the stream in its narrowest part, 45 miles wide, between Cape Florida and the Bemini Isles, which were so remarkable as to overturn all pre-conceived notions. The next section is from the Carysfort Reef Lighthouse to the Bahama Bank, about 50 miles southward of the former, and was examined by Lieutenant-Commander Craven in May, 1859. The next, by the same officer, and in April of the same year, is between Sombrero Kay on the Florida Reefs, and the West point of the Salt Kay Bank, and thence to the Coast of Cuba, near Cayo Piedras; and the fourth is at the point where the Gulf Stream, as a stream, may be said to commence, between the Dry Tortuga and the Havana. This was examined by Commander Sands in 1856.

In the section between the Tortugas and the Havana, thirteen soundings were gained, the distance across being about 95 miles. The stations are not quite equally distributed in distance over the whole interval; but the

following figures will give the common results. The stations commence from the northern side :—

33 35 65 130 200 330 520 610 710 770 fathoms.

It will be seen that the deepest water, about 800 fathoms, is on the Cuban side, being within 5 miles of Havana. This characteristic is followed all the way along the Cuban side and that of the Great Banks. At the Havana, as above shown, there is an abrupt descent of nearly a mile within 5 miles of the shore, while on the side of the Tortugas and Kay West the water is comparatively shallow and the descent gradual.

This fact goes to confirm the conclusion, that the strong current of the Gulf Stream makes the circuit of the Gulf of Mexico (249), since if it impinged directly upon the land of Kay West and the Tortugas, we should find its effects in the wearing of a deeper channel on that side.

(268.) In 1866 it became necessary to lay an electric cable between the Florida Kays and the Havana, and the U.S. Coast Survey, under Mr. Hilgard, undertook the examination of the bottom. The line of soundings was carried from Sand Kay to the Moro Castle of Havana, in a diagonal line across the main strength of the stream, where it first enters the channel which gives its name—a distance of 82¼ miles. To this particular attention is drawn, as it contains the clue to the real character of the Gulf Stream.

Of this breadth of 82 miles, the Gulf Stream does not occupy more than 40 miles on the southern side of the channel, and it was found that the depth of the stream was not more than *one-third* of the entire depth of the channel, or about 1,200 ft., not reaching to the summit of a submarine ridge which was discovered here.*

Such a well-established fact at once overturns all former speculations as to its enormous depth, and high temperature to all depths; for it was found to have only a temperature of 60° Fahr. on the summit of the submarine ridge, and only 45° at the bottom. It will thus be no great sacrifice to abandon pre-conceived opinions.

A single fact also will suffice to show that the Gulf Stream does not fill this narrow channel. Between 1857 and 1862 Capt. E. B. Hunt, of the United States' Engineers, was employed at Kay West, one of the Floridas, on the threshold of the stream.† His careful observations fully bear out the elaborate geological survey by Prof. Agassiz in 1850-51,‡ and demonstrate that these Kays and reefs are slowly, but surely, extending to the *westward* by the mechanical agency of a counter-current North of the Gulf Stream, in direct opposition to the strongest part of the course. During strong weather, the sea about the reefs becomes milky, or "white water," from the bottom being stirred up by the waves. This white water is inevitably

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* See Report U. S. Coast Survey, 1866, and abstract of a paper read before the U.S. Academy of Sciences, by Henry Mitchell, Esq. American Journal of Science, Jan. 1867, pp. 69—74.

† American Journal of Science, &c., vol. xxxv., pp. 197—210, and pp. 388—396.

‡ Professor L. Agassiz in Report of U. S. Coast Survey, 1851. Appendix 10, page 145, 1860.

drifted to the *westward*, and the matter it carries is slowly deposited both North and South of the line of Kays, and to 30 and 40 miles to the southward of them.

(269.) The next section is about 120 miles further East, from the Sombrero lighthouse to the Salt Kay Bank, and four stations were observed in the distance of 45 miles.

60 130 600 375 fathoms.

The last being within 5 miles of the Salt Kay Bank, the descent from the Florida side being more gradual.

(270.) The next section is between the Carysfort lighthouse and the Great Bahama Bank, a line bearing about E. by S. and W. by N., true, distance 63 miles. Six stations were observed, commencing from the Florida side; they were as follow:

120 380? 500? 470? 370? 213 fathoms.

The steepest descent is that on the eastern side of the stream, as before noticed.

(271.) The next is the most important because the most remarkable—that across the narrows of Cape Florida, a distance of 45 miles. It was taken nearly East and West, true, and at equal distances 5 miles apart. The depths were as follow:

72 170 170 260 300 315 325 300 100 fathoms.
320 370

(272.) The *shallowest* and *narrowest* part of the stream is therefore here. From hence northward there is a rapid descent of the bottom from 350 to 800 fathoms, or 2,700 ft., in a distance of 200 miles; and the temperature sinks from 80° on the surface to 40° at the bottom. At this last section, also, instead of the even curve which the bottom seems to have as in the southern sections, it is here somewhat irregular, and hence northward there are some curious variations of temperature discovered in crossing the axis of the stream which are not found to the south-westward, as will be presently explained.

The fact of the shoalest part of the bed of the Gulf Stream being on the Florida side will account for the existence, on that side almost exclusively, of a counter or westward current, which will be more fully dilated on hereafter.

(273.) The same process of deep-sea sounding and gaining the temperature has been carried on at various points to the northward on lines perpendicular to the axis of the stream, extending from the shore to beyond its outer limits. The latest and most eastern being those of H.M.S. *Challenger*, to the N.W. and North of Bermudas, see page 412.

It is difficult to explain the nature of these soundings and their results without accompanying diagrams; but they are, of course, of more utility to the physical geographer than to the sailor. What follows on this head is mainly derived from the Reports of the United States' Coast Survey.

The general plan of exploration of the Gulf Stream, laid down in 1845, was to observe the phenomena on sections perpendicular to its axis from

well determined points on the coast. In pursuance of this design, sections were run from near Montauk Point, Sandy Hook, Cape Henlopen, Cape Henry, and Cape Hatteras, previous to 1848. Lieut. Com. Craven was directed in 1853, in returning from the Florida Reef, to run four sections across the stream from near Cape Canaveral, St. Augustine, St. Simons, and Charleston; and Lieut. Comg. Maffit, after closing his work at Georgetown, South Carolina, to run three sections respectively from Charleston, Cape Fear, and Cape Hatteras.

On the Charleston section, bottom was carried from 10 fathoms, 38 nautical miles S.E. from Charleston Light, to 100 fathoms, 65 miles S.E. from the light. The bottom was not reached at 500 fathoms, nor in 600 fathoms in the stream. At 97 miles from Charleston Light, after crossing the warmest water of the Gulf Stream, bottom was struck in 300 fathoms in the main strength of the current, and was kept at variable depths from 500 to 370 fathoms to 207 miles from the coast, or 80 miles beyond the outer limit of the stream. The bottom was brought up in every case, and has been preserved, showing some very interesting results.

After crossing the Gulf Stream on the Canaveral section, Lieut. Comg. Craven struck soundings of 400 fathoms, at 69 miles from the coast. It appears thus that the existence of soundings of from 300 to 400 fathoms, after crossing the Gulf Stream at these two points of our coast, was discovered independently by the two officers nearly at the same time. In the subsequent sections run by the *Corwin*, soundings were struck 125 miles off St. Simon's in 500 fathoms, and off Charleston in 480 fathoms.

The form of the bottom on the Charleston and Cañaveral sections shoals gradually from the shore to 53 and 36 miles respectively, then suddenly falls off to below the depth of 600 fathoms. On the Charleston section 96 miles from the coast, is a range of hills, steep on the land side, and having a height of 1,800 ft., and a base of about 11 miles on the seaward side; a second range of 136 miles from the coast, 1,500 ft. high, and 28 miles base towards the shore, and 600 ft high, with a base of about 17 miles, on the outer side. Beyond this is a more gradual rise. On the Canaveral section the inner range is 68 miles from the coast. In fact, on the Canaveral section, after sounding at the depth of 1,060 fathoms, the steamer drifting a mile and a quarter, the line showed bottom at 460 fathoms. Both are stated to have been good up and down casts. These first observations, while they are merely a foundation to build upon, are undoubtedly in the highest degree interesting and important in their connexion with the phenomena of the Gulf Stream.

On the sections from Cape Fear and Cape Hatteras, after leaving the shoals near the shore, the depths increase very rapidly.

Lieut. Comg. Craven noticed ripples in connexion with the irregularities of the bottom on the Charleston section. Similar ripples were observed on the Sandy-hook section and on the Montauk section in 1845, and were compared to the "rips" on the Nantucket shoals. These are, however, probably a secondary effect of the irregularities by the changes of current produced.

(274.) As far, then, as Cape Hatteras the bed of the Gulf Stream has been found not to exceed 600 fathoms in depth, and is in many parts very

irregular. To the northward of this, the ocean is very deep. At 200 miles eastward of Cape Hatteras the depth is 2,500 fathoms; at 150 miles eastward of Cape Henlopen 1,500 fathoms; at 180 miles E.S.E. of Nantucket off the S.E. point of George Shoal, 1350 fathoms; at 230 miles eastward of Nantucket, off the eastern edge of George Shoal, 1,340 fathoms, and at 180 miles southward of Halifax, and 40 or 50 miles S.S.E. of Le Have Bank 1,250 fathoms. Between this latter sounding and Bermudas the depths vary between 2,000 and 3000 fathoms. These are depths to which the Gulf Stream has little or no influence, as is shown by the temperature taken by H.M.S. *Challenger*, hereafter quoted, page 412. Although thus deprived of a large portion of the magnitude with which it was formerly believed to be invested, it is not the less a wonderful stream, as it is able, so expanded and thinned out, to maintain its course and character unimpaired over the counter-currents of a totally different origin and nature which flow beneath it.

(275.) **Breadth.**—As has been stated before, it is difficult to define the exact boundaries of the Gulf Stream, which is, in fact, but one out of a series of several. But whilst the more minute examination which has been made has added something to our knowledge of its features, it has not hitherto been sufficiently extensive to fix its limits, either by an average, or, if it is more exactly defined, to give us the position of its margin in different seasons. However, as numerous observations have been given on its drifts, we may give a rude approximation to its extent from the positions where the drift has been found to be appreciable. In the narrowest part it is about 40 miles broad—a breadth it maintains to abreast of Cañaveral. Off Charleston it is about 70 miles; off Cape Look-out, 100 miles; off Cape Hatteras, 120 miles; while off Nantucket, it is probably expanded to 300 miles, so that it has widened to more than seven times the extent it commenced with. That the southern side of the Gulf Stream to the northward of Bermudas is very ill-defined will be best understood by studying the temperatures taken by H.M.S. *Challenger* in April and May, 1873, see page 412. It will be observed that the temperature was higher at Bermudas than at most stations to the northward, both at the surface and below. Only in two observations between Bermudas and Halifax was the surface temperature found to exceed that at Bermudas, and then only by 1°. The direction of the currents in the passage between Halifax and Bermudas (May 20—28) also indicate that the stream here was weak in power. As far as 37½° N. the current was observed to flow in a southerly direction between S.W. and S.E. at rates varying from 10 to 26 miles in the 24 hours. In 37° N. the current flowed strong to the eastward 32 miles. In 36½° N. only 7 miles N.E.; in 35° N. 7 miles E. by N, and at 60 miles North of Bermudas a weak current of 3 miles flowed to the N.W. The wind in this passage southward of 40° N. was generally from the N.E., and varied in force from 3 to 7 Beaufort Scale (p. 180), btween 40° N. and 36° N. southward of this it was very light.

(276.) **Velocity.**—We abandon the calculation which we made in 1856, of the velocity of the stream, as derived from the data given by Rennell, Maury, and numerous other authorities. Generally—perhaps it may be said always—these observations gave a higher rate of motion than subsequent and more carefully corrected observations have shown to be the case. The

work of the Meteorological Office, before quoted, the Currents of the North Atlantic between the Equator and 40° N., as drawn up by Mr. Strachan, at first under the direction of the late excellent Admiral Robert Fitzroy, and afterwards by his successor Robert H. Scott, Esq., M.A., must now be taken as the standard authority, and from it we take the following general, and then the monthly observations on the Gulf Stream, as far as the parallel of 40° N., above-mentioned.

(277.) *The Gulf Stream*, as far as the observations on these charts go, may be considered to commence near the delta of the Mississippi. A current setting N.E. by N., averaging 20 miles a day, in lat. 26° to 28° N., long. 95° to 90° W., appears to cross the 90th meridian, and unite with the Gulf Stream, which takes a direct course to the Florida Reefs, setting S.E., its rate increasing from 9 to 29 miles per day, in a distance of about 500 miles. On the right it has the Yucatan current which it forces westward. At times part of this S.E. current finds its way round the West end of Cuba into the Caribbean Sea, as has been previously explained. On the left there appears to be an off-flow towards the E.N.E., and North of the Florida Isles, about lat. 26° N., long. 83° W., the configuration of the land occasions a sort of eddy, and the currents experienced there are extremely variable in direction. There being no outlet for the waters towards the N.E., and the Yucatan current confining it on the S.W., the main part of the stream is forced into the Straits of Florida, turning to the N.E. by E. in its passage between the Florida Reefs and Cuba at a mean rate of 39 miles. About lat. 25° N. the straits between Florida and the Bahama Banks become contracted, part being known as the Narrows. Here the set becomes almost due North, and its rate greater, averaging 48 miles. This rate and set is maintained to lat. 30° N. Thence to lat. 32° or 33° N., the direction of the set is N.E. by N., while the rate has decreased to 40 miles. Now the set changes to N.E, and is maintained to lat. 38° N., long. 70° W., the mean rate of the main stream being from 48 to 43 miles. The stream is strongest towards the land side, being pressed upon by the Artic current, which probably causes the very high velocities sometimes experienced about lat. 36° to 38° N., long. 74° to 70° W. On the right side the stream is free to spread out, being only resisted by a feeble westerly drift. Here accordingly we find the current weaker, even down to 10 to 20 miles a day. It must be remarked, however, that the observations made on the right edge of the stream must frequently be in part due to the influence of the westerly, or rather south-westerly drift, upon the ship's run in 24 hours, the final result depending on the preponderance of one or the other current during the interval. Whenever this has been suspected the observations have been separated from those believed to have been made entirely in the Gulf Stream, and averaged by themselves. In long. 70° W. the width of the stream averages about 120 miles, extending from lat. 36° to 38° N. Thence its set becomes E.N.E., and its main portion seems to pass North of lat. 40° N., the limit of the Chart, near long. 60° W. Between 70° and 60° W. the rate is from 37 to 27 miles per day. The southern edge of the stream can be traced to long. 45° W., about lat. 38° N., but the rate is feeble and the set variable.

The temperature of the Caribbean Sea is above 80° from July to October,

during the rest of the year it is below 80°; the minimum, about 75°, occurs in February and March. In the same latitudes, nearly 10° to 20° N., off the African coast, the lowest temperature occurs in January, and the highest in July, when it rises to above 80°, as in the Caribbean Sea; but with this exception these eastern waters are always from 3° to 7° colder than the western.

It will be noticed that the maximum and the minimum temperatures take place later in the year in the Caribbean Sea than off the African coast. This circumstance is probably due to the prevalent currents.

The Gulf Stream keeps the sea off the Southern States of the United States, from the Mississippi to Cape Hatteras, at a temperature above 80°, from June to October; above 70° during January, February, and March; and above 75° during the intervening months, April and May, November and December.

In striking contrast to this high and equable temperature of the seas of the Southern States, is the low and variable temperature of the seaboard of the Northern States, from lat. 40° to 36° N, due to the presence of the cold Arctic current. Here in January, February, and March, the temperature of the sea falls below 50°; in April and May, and also in November and December, it is below 60°; in June and October it is below 70°; and in July, August, and September, it attains to 75°. Where the warm waters of the Gulf Stream intermingle with, or flow side by side with the cold Arctic current, the changes in the temperature of the sea are large and sudden, and are noticed by all navigators of that region. If we contrast these extreme changes of temperature off the American coast with the slow change observed off the coast of Africa, the influence of currents in modifying the temperature of the sea and determining climatic peculiarities becomes strikingly evident. With this view the following tabular statement has been compiled from the charts, from which it appears that on the meridian of 74° W., the change of temperature from lat. 40° to 35° N., or in 300 miles, is on an average 18°; while on the meridian of 20° W., from lat. 40° to 10° N., a distance six times as great, the average in the temperature of the sea is but 15°.

Months.	Sea Temperature in Lon. 74° W.		Change in 300 Miles.	Sea Temperature in Lon. 20° W.		Change in 1,800 Miles.
	Lat. 40° N.	Lat. 35° N.		Lat. 40° N.	Lat. 10° N.	
	°	°	°	°	°	°
January ..	49	68	19	60	70	10
February..	39	67	28	57	73	14
March....	45	70	25	58	78	20
April	50	70	20	57	78	21
May.....	54	77	23	58	76	18
June	62	79	17	62	80	18
July	69	82	13	66	76	10
August ..	72	78	6	70	80	10
September	65	78	13	71	81	10
October ..	62	75	13	69	82	13
November.	56	72	16	65	80	15
December.	50	71	21	60	80	20
Average ..	56	74	18	63	78	15

In *January* the Gulf Stream may be traced from about long. 87° W. between lat. 25° and 30° N. Thence it flows to the S.E. and East between Florida Reefs and Cuba, and is forced to the northward by Florida Channel, where its rate is 39 miles. Beyond this, observations are deficient, but they indicate the stream as far as 37° N., 70° W.

In *February* it can be traced from the 85th meridian, between lat. 23° and 27° N., through the Gulf of Florida, northward to lat. 32° N., thence northeastward to lat. 37° N., in long. 72° W., data are wanting beyond this. Its rate, North of Cuba, is 33 miles; through the Narrows, 53 miles; thence to lat. 32° N., 48 miles; beyond this, observations vary from 70 to 21 miles per day. A counter current to the south-westward is indicated from 35° to 30° N., which appears to become deflected to the E.S.E. by the Bahamas, but its force is inconsiderable, and it is probably variable in direction as well as in rate.

In *March* it seems to commence about lat. 28° N., long. 90° W., whence it flows S.E., rapidly increasing in velocity, passing around Florida at the mean rate of 40 miles, which it maintains up to lat. 30° N. Farther northward observations are not so numerous, and while they indicate a current to the N.E., and then E.N.E., up to lat. 37° N., long. 62° W., they assign to it extraordinary differences of rate. One observer vouches for a rate of 106 miles in 24 hours, about mean position 37° N., 72° W. From 30 to 35° N., the stream is reported as unusually weak in this month. There is evidence of a southerly set between 27° and 30° N., eastward of the Gulf Stream, as far as long. 70° W.

In *April* the Gulf Stream appears to commence at the mouth of the Mississippi, flowing south-eastwardly towards Cuba, where it is turned eastward, and then to the N.E. and N. round Florida. Commencing with a rate of 22 miles, it becomes 36 miles off Cuba, and 48 miles off Florida, maintaining this rate to lat. 32° N. Its direction is now to the N.E., but its rate is undiminished to lat. 35° N. Beyond this, observations indicate the current to long. 58° W. in 38° N. It appears to extend from the coast to 65° W. on the parallel of 36° N. The counter current to the S.W. is shown considerably farther eastward than in the previous months, being to the East of the 70th meridian in lat. 31° N. Its rate is from 11 to 22 miles.

In *May* it may be considered to commence from the delta of the Mississippi, with a rate of only 16 miles, but flowing S.S.E. it becomes 27 miles; then E.S.E. 35 miles, and passes between Florida Reefs and Cuba at the rate of 44 miles. Between Florida and the Bahamas it has the greatest mean strength yet noticed, 64 miles. Thence it continues N., N.N.E., N.E., and E.N.E., at a mean rate of 40 miles, until it reaches lat. 37° N., long. 70° W. Eastward there are indications of this current across the Atlantic, as far as the Azores, the rates given varying from 6 to 29 miles. On the whole, this stream appears to be stronger, and to extend farther into the open ocean, than in April. There is evidence of a remarkable overflow from the Gulf Stream, setting E.S.E., at from 14 to 22 miles per day, between lat. 28° and 33° N., and shown as far as 70° W.; also into the Santaren Channel, as if all the water could not pass with the main stream.

In *June* it may be considered to commence off the Mississippi at 12 miles per day. Thence it flows S.E. towards Cuba, at from 17 to 38 miles, then

East between Florida Reefs and Cuba, at 50 miles. From lat. 25° to 30° N. there are no observations of it. From lat. 30° N. it flows north-easterly to lat. 35° N., at from 46 to 63 miles. Between 35° and 40° N. it becomes more easterly, and its rate is variously given, from 14 to 48 miles. It can be traced to long. 45° W. in lat. 37° N. There is no evidence that it reaches the Azores. It has greater extension southward between long. 55° and 70° W. than has been noted hitherto. There is no evidence of an overflow North of the Bahamas, although the stream appears to be quite as strong as in May.

In *July* the Gulf Stream may still be traced from the Mississippi, flowing south-easterly towards Cuba, at a rate of about 24 miles. Between Florida Reefs and Cuba it attains 51 miles, and from 25° to 30° N. it has been found to average 72 miles nearly due North. Thence it flows eastward of North to lat. 36° N. in long. 70° W., at a rate of 30 to 43 miles. Its set is now eastward, and can be traced to long. 35° W., but the observations are neither numerous nor consistent. On the whole it appears that the Gulf Stream is very strong this month, and that its southern limit is in lat. 36° N., between 40° and 72° W. longitude.

In *August* the Gulf Stream, also, is not represented from its origin to lat. 35° N. From 35° to 40° N., and between 75° and 55° W., it appears to be strong, the rates varying from 12 to 56 miles. In the same latitudes, between 45° and 30° W. longitude, there is decided evidence of a southerly set.

In *September* it is traceable from lat. 30° N., long. 80° W., at 72 miles a day, to 38° N., 63° W. at 31 miles. Between 60° and 70° W. it does not appear to extend farther South than about 37° N.

In *October* it passes through the Straits of Florida at 37 miles per day, but the observations are deficient in number.

In *November*, on the East of Florida, it has a rate of 70 to 53 miles; in lat. 34° N., it is 46 miles. Elsewhere there are no data.

In *December* the Gulf stream is well shown from long. 87° W. to 67° W. In its south-easterly flow to the West of Florida its rate is from 10 to 20 miles. East of Florida it flows due North, at from 50 to 54 miles. Thence to lat. 38° N., in its north-easterly course it maintains the rate of from 38 to 58 miles.

The Arctic Current, between the Gulf Stream and the coast, has been frequently experienced, its rate being from 10 to 15 miles. It may be the pressure of this cold water which causes the remarkable increase in the rapidity of the stream about lat. 37° N.

(278.) *In the Strait of Florida*, within the Bahamas, when a northerly gale, increased to a storm, opposes the stream in its course, this adverse power causes it to fill all the channels and openings amongst the Martyr Isles and Reefs, and to overflow all the low coast. Shipping have even been carried over the low cays, and left dry on shore.

In the month of September, 1769, there happened an inundation, which covered the tops of the highest trees on the Cayo Largo, &c., and during which the *Ledbury*, snow, John Lorain, master, was carried over the reef by the N.W. current of the stream, caused by a gale from the N.E. The vessel

bilged in shallow water, but an anchor was thrown out, and the next day the vessel was found to have grounded on Elliot's Kay, with its anchor among the trees.

The water is supposed at times to have risen to the height of 33 ft., and to have been running against the fury of the winds at the rate of 7 miles an hour. During these times the Strait of Florida exhibits a scene beyond description.

Besides the effect which different winds have upon the stream, it is subject to another power that also directs it toward or from the coast; and that is, the moon, which, according to her position, has different effects upon it, not, however, in equal power with those of the wind; but the disposition of the stream is increased to its extreme, if the effect of both the wind and the moon are combined; for at this time, the ocean rising highest, this regulates the flood and ebb, and divides them in proportionate times; consequently it directs and increases them, with an easterly moon and wind to the West, and with a westerly moon and wind to the East; so that the West and East shores are at times deprived of, and at other times overflowed by, tides, occasioned by these vicissitudes.

The boisterous East, N.E., and North winds which affect the Gulf Stream, generally begin in September, and continue until March; when, if the moon happens just at the time to be on the full or change, they commonly end with a hurricane.

(279.) Captain Livingston has said:—"The calculations of the velocity of the Gulf Stream are not to be depended on. I have found it setting at the rate of 5 knots, and even upwards. This was on the 16th and 17th of August, 1817. On the 19th and 20th of February, 1819, it seemed to be almost imperceptible. In September, 1819, it set at much about the rate described in the charts."

One remarkable instance of its diverging from the usually supposed velocity is given in a communication of Captain Giles, of the barque *Charles*, who found it to run 5 and 5½ knots, in January, 1843. "The first day I began to make any material progress was with the Tortugas bearing about S.E.; the following day I had a current of 53 miles S.E. by S.; the next day, 60 miles S S.E. ½ E. I was then in lat. 24° 10′, long. 83° W. The weather would not permit our sighting the Tortugas, though we passed them very closely. The next day we made, by very good observations, 75 miles of due easterly current, which, with the ship's work, placed her in lat. 24° 12′, and long. 81° 33′ W. The succeeding day, towards dark, the wind being strong from E.S.E., and considering myself in the vicinity of the indraught of the Great Inlet, I put the ship's head to the southward, under *close-reefed* topsails, and nothing more set, and reached her to till daylight, that being twelve hours good; towards noon it fell calm. I then found that we had been set nearly in the direction that the elbow of the land trends *one hundred and ten miles*, we being at noon in lat. 25° 15′ N., long. 79° 45′ W. The following day we had light, variable airs and calms, heavy rain, much thunder and lightning, and very thick weather (as it had been the day previously). We picked ourselves up at noon, lat. 27° 20′ N., and long. 79° 30′ W., having had the current N. by E. *one hundred and twenty miles*. I intended to pass through the Providence N.W. Channel, but the current

swept us past the mouth of it in the light airs which we had on the last two days of our passage."

(280.) *Captain* (aft. General) *Sabine*, F.R.S., says:—"There can be little hesitation in attributing the unusual extension of the stream in particular years to its greater initial velocity.

"On the 5th of December, 1822, the *Pheasant*, bound to New York, quitted the northern boundary of the stream in lat. 36½°, long. 72½°. In the stream, in latitude 36° 14′, long. 72° 25′, the temperature of the surface water was 74°, and of the air, 65°. Between 10 a.m. and noon the temperature had fallen from 74° to 62.4°, being a difference of 11.6. The surface water on which the ship entered was in motion to the westward, at the average rate of 16 miles in the following twenty-four hours, and generally to the West and S.W. between the northern side of the stream and the banks on the coast of Maryland. This motion may be more properly characterised as a *drift* current, occasioned by the prevalence and strength of recent northerly gales, than as a *counter* current. In approaching the bank (or soundings), the surface water at eight a.m. and at noon, on the 7th of December, was 59.5°; at three p.m. it had fallen to 54.2°; on which, upon sounding, bottom was found in 33 fathoms; on the following morning, in 30 fathoms, the surface was 53.5° and at eight a.m. on the 19th, in 12 fathoms, but still with no land in sight (being 20 miles off the coast), 41.5°. In the afternoon of the same day, when about 2 miles distant from Sandy Hook (New York Harbour), the water had finally lowered to 45°. Thus, in a space of the ocean scarcely exceeding 200 miles in direct distance, the heat of the surface progressively diminished from 74° to 45°."

(281.) **Temperature.**— The high temperature of the Gulf Stream is one of its chief characteristics, and has attracted from very early times almost as much attention as its velocity. A work was composed on this subject, entitled "Thermometrical Navigation," written by Col. Jonathan Williams, and published at Philadelphia, 1799, from which the following extracts are given.

Commodore Truxton says:—"In the stream the water is much warmer than the air; indeed, I have known it 10° warmer; but as soon as you get within the stream (that is, between it and the coast), the water becomes colder than the air; and the more as you get on soundings, and approach the shore. If mariners, who have not the opportunity of determining their longitude by celestial observations, will only *carry with them a good thermometer*, and try the temperature of the water, and compare it with that of the air every two hours, they may always know when they come into or go out of, the Gulf Stream. Indeed, I have always made a practice, when at sea, of comparing the temperature of the water and air daily, and often very frequently, during the day, throughout the voyage; whereby I immediately discovered anything of a current that way going, and afterward found its strength and directions by observations for the latitude and longitude. It is of the utmost consequence in making a passage to and from Europe to be acquainted with this Gulf Stream; as, by keeping in it, when bound eastward, you shorten your voyage; and by avoiding it, when returning to the westward, you facilitate it inconceivably; so much so, that I have frequently, when bound from Europe to America, spoke European ships,

unacquainted with the strength and extent of it, off the Banks of Newfoundland, and been in port a very considerable time before them, by keeping out of the stream; whereas they lengthened their passage by keeping in it. The general course of the Gulf Stream being marked on the chart, I would advise those who make the northern passage from Europe never to come nearer the inner line of it, by choice, than 10 or 15 leagues; and then probability will be that their passage will be assisted by the help of a counter-current, which runs within it. In coming off a voyage from the southward, be sure to steer N.W. when approaching the stream, if the wind will permit you; and continue that course until you are within it, which may be easily known by the temperature of the water, as before mentioned. I have always considered it of the utmost consequence, when bound in, to cross the stream as speedily as possible, lest I should be visited by calms or adverse winds, and by those means driven far out of my way, which would prolong the voyage considerably, especially in the winter season."

(282.) From the fact that when crossing the Gulf Stream from East to West, the temperature *suddenly* fell when its western edge was passed, that is, coincidently with obtaining soundings, it was argued by Colonel Williams, and long maintained that the thermometer would certainly indicate the approach to soundings by a fall in the temperature of the water in any part of the ocean.

From the facts quoted, he infers that, "By the coincidence of these three journals, at so great a distance of time, and without any connection with each other, this important fact seems to be established:—*A navigator may discover his approach toward objects of danger, when he is at such a distance as to be able easily to avoid them, by attentively examining the temperature of the sea;* the water over banks and shoals, in these regions, being colder, in general, than that of the deep ocean."

Now although this remark holds good as to this portion of the American coast, and in some other parts of the world, under similar influences, yet it is founded on a fallacy, and certainly has not that universal application which former observers endeavoured to claim for it. This question is now generally well understood, and it is only necessary thus to refer to it, as a memorial of past times. When it was first promulgated, the extension of the Arctic Current to the southward in such a remarkable manner inside the Gulf Stream was not suspected. And although Mr. Redfield's views, given hereafter, are now fully maintained, yet the more extended observations of the United States Coasts Survey, have revealed such singular facts, that even now we must confess that our knowledge of the compensating system of the ocean is exceedingly imperfect.

(283.) The *mean surface temperature* of the Gulf Stream, in the early part of its course may be ascertained from the vast and confused mass of figures contained in Captain Maury's Thermal Charts. The temperatures thus recorded, however, show large variations between themselves in the same periods. This may arise from two causes—the one from the variation known to exist in the stream itself, and which is frequently considerable; and the other from the imperfection of the thermometers used, and this, as many of the observations appear to have been derived from voyages made before standard thermometers were employed, may include a considerable

portion of the discrepancies which exist. Another and very important addition to this branch of the subject, is the work of Lieut. Andrau "Onderzoekingen met den Zeethermometer," published by the Netherlands Royal Meteorological Institute, Utrecht, 1861.

The following are the result of the calculations for the temperature of the main strength of the current from the narrows of the Little Bahama Bank to the meridian of Halifax. To the eastward of this, or long. 60°, the temperature, especially in winter and spring, becomes rapidly lower and very irregular, as will be presently alluded to, and therefore our comparison will now be limited to this section, which comprises a distance of about 1,200 miles, and which is traversed by the stream in about 25 to 35 days.

Upon comparing these temperatures, which are carried so many miles unimpaired by the Gulf Stream with the inner Arctic Current between the stream and the shores of Virginia, New Jersey, New York, &c., a surprising difference will be seen, especially in the spring months, when the difference is at a mean 30°, and other seasons from 15° to 23°. This will be more fully entered into in the next section.

(284.) It has been found that the temperature of the stream varies in a greater degree than could be accounted for by the climates it had passed through, being sometimes warmer to the North, and cooler to the South, of any particular position. This seems to be accounted for by the variability of the source of the stream in the Gulf of Mexico and elsewhere, which it would be very difficult to follow up to any specific determination.

(285.) *Warm Bands.*—The Gulf Stream was found, in the early operations in its investigation in 1845-48, to consist of a series of alternations of cold and warm water, a fact which was very surprising at the time, but the results of the latter explorations in 1853, entirely confirm the former ones in this respect. In fact the Gulf Stream is merely one of a number of bands of warm water separated by cold water. The observations on the Hatteras, Cape Fear, and Charleston sections, show a *counter-current* where the cold streaks are found; and as these observations and those for temperature are entirely independent of each other, the coincidence in result is very striking. This fact is of too great importance not to be carefully followed up. It would appear from general reasoning, that this was not unlikely to be the case."

On the land side, the division between the cool and warm water is very distinct. It is now concluded that this separation into distinct belts is owing to the form of the bottom, as they appear to be strongest North of the section of Cape Cañaveral, where the range of submarine hills and dales (272) is found very much to coincide with the position of those cool and warm belts; and this conclusion is strengthened by the fact, that South of Cape Florida, where the bottom is even, they disappear altogether.

(286.) *Subsurface Temperatures.*—It was formerly held that the Gulf Stream flowed on in one majestic current of warm water from its surface to its bed. The magnitude of its effects and the extent of its area seemed to leave room for no other conclusion. But the first observation of ice-cold water at a small depth in its narrowest and strongest part overturned all these hypotheses, and left a most perplexing condition in which we are at a loss to

know where to look for an explanation.* How this cold water, flowing directly contrary to the course of the upper strata, should preserve its polar characteristic almost unimpaired to such an enormous distance from its origin, and under such apparently adverse circumstances, cannot be explained with our present views. Again, by what power, or source of action, are the lower strata made to move in an opposite direction to those superincumbent upon them, and which, it might be supposed, would be acted on by the same laws and move in the same manner? It is one of the most remarkable evidences of that grand compensating system by which the Great Creator has commanded that all the harmonies of the universe shall be maintained—which keeps the atmosphere and ocean in a perpetual condition of interchange, and thus makes them fit for the sustenance of his creatures.

We have alluded to this universal intermingling of the ocean waters before (168). Of the presence of polar water in these tropical regions there can be no doubt. The following extract from the Report of the Superintendent of the U. S. Government Survey will place it beyond question:—

"The southern sections present on a small scale, the same phenomena which we formerly traced over a large expanse in the more northern ones. Examining the Cañaveral section, which is the furthest South, we see the cold wall almost as plainly as on that from Sandy Hook; the curve, showing the mean results between 70 and 100 fathoms, rises some 17 degrees, from 57½° to 74½° Farenheit, in the distance of 23 nautical miles. The warm water, overlying the cold, is deeper in its overflow towards the shore—that is all. Passing the warmest water, there is a fall of temperature of several degrees, followed by a rise. On the St. Simons section the cold wall is again well shown, and is the first of those distinct bands of minimum temperature dividing four maxima, of which the greatest body of warm water of the Gulf Stream is the second from the shore. Near the surface the first and fourth maxima are the highest; at 15 fathoms, the first and second; at 150 fathoms, the successive maxima rise as they recede from the shore. The Charleston section presents, as a general feature, between 25 fathoms and 250 fathoms four minima and three maxima. Within the cold wall minimum is a decided *warm* belt, and probably further on in-shore is a cold one. The rise in the mean of the temperature at 20 and 30 fathoms is 11° Fahrenheit, namely from 64° to 75°. The advantage of not relying on surface temperatures, or those near the surface, where the distribution is so much

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* In the experiments made by the United States' Coast Survey the temperature was gained from all depths, from the surface down to 600 fathoms. At great depths a peculiar thermometer was used, constructed for the purpose, whose principal of action depends on the differing expansion of two metals. It is a spiral coil composed of two strips of silver and platinum soldered together, which, from their unequal contraction and expansion by the effects of temperature, act on an index, which registers the extreme temperatures.

But later experiments have shown that many of these results are fallacious, both as respects this differential evil, and especially with the ordinary thermometer with unprotected bulb as was formerly used; and therefore all of them will require revision, as the probability, nay certainty, is that the recorded temperatures at great depths have been placed much too high. Of this more hereafter.

less regular and marked than below, will be recognised in all these results, and was early provided for in my instructions.

"The underlying cold water from the northern regions is as plain in the southern section as it was in the more northern. 400 fathoms vertically below the warmest water of the Gulf Stream, on the Cape Henlopen section, in August, 1846, the temperature was 49° Fahrenheit, and in the same position off Cape Cañaveral, in June, 1853, it was 48½°.* The latitude corresponding to the first temperature was about 37° 20′, and to the last about 28° 20′. Lieut. Charles H. Davis, in October, 1845, found a temperature of 40° at 1,000 fathoms, in lat. 39° 25′, and long. 69° 1′, and Lieut. George M. Bache 40° at 2,160 fathoms, in lat. 34° 13′, long. 68° 5′. Lieut. S. P. Lee, in August, 1847, found 37° below the Gulf Stream, at the depth of 1,000 fathoms, in lat. 35° 26′, long 73° 12′; and again 48° beyond the Gulf Stream, at the same depth, in lat. 30° 10′, and long. 68° 9′. Lieut. Richard Bache, in July, 1848, found a temperature of 42° at 1,000 fathoms, in lat. 35° 6′, and long. 74° 7′, below the surface of the Gulf Stream.

"The fact that the side limits of the polar current recede from the shore as the depth increases, is clearly marked on all the sections. Directly down below the maximum surface temperature we soon plunge into this cold current, the warmer water receding from the shore, and at 400 fathoms reach temperatures, the differences between which at the North and South, are of an order corresponding to the variations of the ocean waters in different years and at different seasons. For example, at the depth of 400 fathoms, on the Sandy Hook section, in 1846, vertically below the crest of the Gulf Stream the temperature was 51° Fahrenheit; on the Henlopen section, at the corresponding point, 51°; on the Cape Henry section, 54½°; in 1848, on the Cape Henry section, 52½; and on the Hatteras section, 52°; in 1853, on the Hatteras section, 51°; and on the Cape Fear section, 54°; all the foregoing observations being made in July and August of the several years. In June, 1853, the temperature at the point and depth before noted on the Charleston section, was 55°, and near Cape Florida, 14 miles E.N.E. from the light, was 51°, varying from 54° to 46° in the intermediate localities. The low temperature of 46° was observed on the Cañaveral section. The temperature at 400 fathoms, near Cape Florida, is the same as was observed on the Sandy Hook section in July, 1846, viz, 49°.

"I remarked that these differences came within the annual changes near the surface. Not to complicate the examination with surface irregularities, if we compare the maximum temperatures at 12 or 15 fathoms below the surface of the different sections, in the same year, we shall find, as a general rule, an increase of temperature in passing southward, as 81°, 83°, 82°, from the Sandy Hook to the Cape Henry section; in 1846, 75½, 76°, 77½°, 79½°, from the Charleston section to the Cape Cañaveral. But in successive years we have for the highest temperature at 12 fathoms, on the Cape Henry

* Reference may be again made to the note on the previous page relating to these deep sea temperatures. The comparisons with the recent, show that these temperatures are too high by 2° or 3° at 500 fathoms, and perhaps as much as 6° or 10° at 2,000 fathoms. This is owing to the great pressure of the water on the *unprotected* bulb of the thermometer forcing up the mercury.

section, higher than that of Hatteras; and the temperature in July, 1846, on the axis of the Gulf Stream, higher at Sandy Hook than in June, 1853, at Cañaveral, by a degree and a half, and higher than Charleston by five and a half degrees. It is obvious that here an interesting field of enquiry opens, requiring careful research."*

(287.) *The Cold Wall.*—The separation between the warm, deep, blue waters of the Gulf Stream and the inner cold counter-current is sometimes so well marked that "one end of a ship is seen in the one, and the other end in the other current." Although it does not follow that this line of demarcation is as distinct as Captain Maury says, as above, yet a remarkable feature has been eliminated by the United States' Coast Survey so often quoted here. It is, that the separation between the two currents is so well marked beneath the surface, and to the greatest depths, as to have obtained for it the title of the "Cold Wall," being, in fact, an upright division between them. This peculiarity has been found to exist almost along the whole coast of the United States, where the stream skirts the bank of soundings. Without diagrams the features cannot be made quite intelligible; but the main fact, so interesting to the physical geographer, is as above stated—that there appears to be a marked non-affinity between the waters flowing in opposite directions.

It was at first supposed the cold wall was cut off at Cape Hatteras, but the subsequent researches have qualified this notion. The cold water has been traced as far as the Tortugas. Off the Sombrero Kay the cold wall was strongly marked at depths varying from 70 to 100 fathoms, while everywhere the warm water overflows the cold wall, and reaches quite to the shore.

The shallowness of the stream in the Strait of Florida, connected with the fact that the bottom falls off rapidly to the North and South, afforded an excellent opportunity for testing the question whether the cold water of the under polar current is forced upwards by the change in depth—as, should this be the case, the cold water would appear in the shallow part of the strait; and this has actually been found to be the case, as the warm surface water of the temperature of 80° and the cold water of the bottom of the temperature of 49° nearly approach each other. It does not follow by this that the "waters run up hill," as has been stated.

(288.) **Counter Currents.**—Besides the great arctic current which flows southward inside the stream to be described in the next section, there are some other counter-currents on each side of the stream which require notice here. They appear in the first part of its course in the Gulf of Florida, where they have been known to flow from the earliest times, as has been alluded to in (253), page 381.

(289.) *The Counter-Current along the Florida Reefs* is marked on all the old surveys of these reefs, and is, during the summer months especially, frequently met with. It may be readily accounted for. On page 389 (266) it will be seen that the main strength of the Gulf Stream, after passing the "Great Whirlpool"† of the Mexican Gulf, runs with the greatest swiftness

* Professor A. D. Bache, Report U.S. Coast Survey, 1853, pp. 48-9.

† See Dr. Lorimer, April 21, 1769, "Trans. Amer. Phil. Soc., Philadelphia," vol. i., p. 250.

past the coast of Cuba, and that the channel is by much the deepest close to the South side, and slopes more gradually from the North. On the shallower water, but not within the reefs, this counter-current runs, by which a vessel may with ease and knowledge work to westward. It may be taken as an eddy, aided by the trade wind, which may give it an additional impetus. It has been well elucidated by Lieutenant E. B. Hunt, Engineer, U.S.A., who, having stayed in the neighbourhood for some time, obtained some particulars from the well-informed residents of these Kays.*

(290.) Captain Geiger, who for some thirty years, has been observing the waters of this vicinity, most of that time having acted as a pilot off Kay West Harbour, and who is, perhaps, better acquainted than any other person with the currents there prevailing, gives the following statement of facts:—

A strong North or N.E. wind keeps the Gulf Stream back, and makes a westerly current near the shore. During June, July, and August, the westerly current prevails more than the easterly current from 5 to 15 miles from the reef. The direction of the current depends mostly on the wind. The westerly current prevails for from one-third to two-fifths the entire time from year to year, for from 2 to 15 miles outside the reef off the West. He has known it 25 to 30 miles off Sand Kay.

When the Gulf Stream is strongest on the Cuba shore, the westerly current is strongest on the North side; and when it is weakest along the Cuba shore, the Gulf Stream sets close along the reef. He has found the westerly current as far up as Carysfort, but not frequently, and not broad or strong. The current broadens from Carysfort to the westward, and continues about constant along its course.

The tides on the two sides of the reef are about six hours apart on an average, but set, on the whole, as much one way as the other over the reef. Sometimes there is a narrow *easterly* current for a mile from the reef, then a westerly current, and then the Gulf Stream. A considerable number of the Gulf traders know of, and make use of, this current in going westwardly. After northers the westerly current may be expected. Sometimes in crossing to Havana no Gulf Stream indications are found, and sometimes a westerly current is found along the North shore of Cuba.

Notwithstanding Captain Geiger's long observation of these currents, he says that he is quite unable to reduce them to rule, or in any way to know beforehand how the current will be found to set.

Captain Richardson, pilot, of the United States' Coast Survey steamer *Corwen*, says:—"The westerly current appears irregularly, chiefly in winter, but sometimes during the prevalence of the regular trades. It extends from 10 to 15 miles off from Sand Kay, and runs sometimes two miles per hour. It never prevails over the reef proper. It spreads further from the reef as it goes West. Off Indian Kay it sometimes extends 7 miles from the edge of the reef; at Bahia Honda, sometimes 10 miles; and at Sand Kay, from 10 to 15 miles. Some years (as in the winter of 1856-7) there was

* Silliman's American Journal, March, 1859, vol. xxvii., pp. 207—214. See also the remarks on page 390, relating to the "white water" of the Tortugas.

very little of this current. The Gulf Stream usually runs stronger on the Cuban side. In one case, in 1852, two vessels bound East passed Tortugas, which separated about 100 miles in twenty-four hours, by one captain knowing this current and the channel, while the other kept in the westerly or counter-current. The tide below the Quicksands and Tortugas sets flood N.N.E., and ebb S.S.E., differing from the Charts."

(291.) But this counter-current, also, is felt on the Cuban side sometimes, probably all the way from the Bahama Old Channel. Of this we have several instances from the communications of Captain Livingston and others; the most singular of these, however, is that of Captain Loudon, of the brig *Perry*, on returning, in the latter part of November, 1827, from New Orleans to Liverpool. Captain Loudon had made the *Iron Hills* in Cuba; shortly after noon he tacked ship to the northward and westward about 8 or 9 miles off shore; next day he kept beating to windward, as near to the middle of the strait as he could judge, and without sighting the land on either side, the wind then blowing a fresh gale to the northward; and he continued beating in the same manner until about eight a.m. of the second day, when, by *reckoning*, he ought to have been near the Salt Kays; but obtaining a lunar observation, it showed, to his astonishment, his longitude to be to the westward of 83°. Supposing his observation to be erroneous, he took a second set of lunar distances, which gave a similar result. Still, however, doubtful, he stood on, and in a short time afterward gained soundings on the *Tortugas Bank!* The northerly gale had now abated, and he worked his vessel in, on soundings, to the northward of the Dry Tortugas. With a favourable wind he ran through the Tortugas Channel; but as light and baffling winds succeeded, he made for the stream as it became dusk, and with such wind got through the strait in the two following days, having, on his way, found the current very rapid along the Martyrs. Captain Loudon justly remarked, that so extraordinary a circumstance, of which he is *positively certain*, ought to be generally known.

"Masters of vessels from Vera Cruz, &c., to Havana, often lengthen their voyage by keeping away too much to the southward after rounding the Dry Tortugas, fearful of being carried away to the eastward of Havana by the strength of the Florida Stream! Some have fetched in about the Port of Honda, the Cock's Comb, and one vessel even as low as Cape Antonio."—*Lieut. John Evans.*

(292.) *Easterly Drift from the Gulf Stream, on the North and N.E. of the Bahamas, &c.*—The Gulf Stream about the Bahamas appears to have a drift or tendency to the eastward; and there is reason to believe that an off-set of the stream, from without the Mantanillo Bank, sets, if not generally, very frequently, to the eastward and S.E. It would seem as if the stream in passing eastward along the southern Florida Kays still kept on this easterly course with a considerable rate over the shallow Bahama Banks, and in the deep channels to cause very uncertain streams.

Capt. Livingston has said:—"The notices we have, tend to prove that an easterly set-off from the Gulf Stream sets to the northward of the Bahamas; of this I am so firmly convinced, that if in charge of a ship from the Havana, or even New Orleans, bound to Jamaica, I should, if allowed to follow my

own plan, run out of the Strait of Florida, and attemp making my passage with the aid of this set-off. This is to be undersood, in case I should not have westerly winds in the southern parallels; for such winds are, I am told, more frequent than formerly; and I know that they are by no means of rare occurrence on the S.W. of Cuba."

(293.) The last remark is one that would be adduced by many to prove that the surface of the Gulf Stream is *roof-shaped*, and that any floating body remaining inactive on it has a tendency to drift to its margins, especially to the eastward and south-eastward. How far this assumption will be borne out by more exact observation, it is difficult to judge, but there certainly seems to be some ground for the opinion, as its edges especially are marked by a larger collection of Gulf weed and other drift matter than are found in the centre. Again, there seems to be a tendency for vessels to be floated to the East and S.E. without their knowing it. It has been urged by Captain Maury that this may be owing to the effect of the earth's rotation, which runs the current from under the ship, and, as he says, the tendency of a railway train going North or South, is to run off the rails to the eastward of its route. This has been made the subject of some interesting experiments by M. Foucault and others; but we know so little that it were futile to argue on it.

(294.) In the northern regions of the stream, when the cold upon the land is in winter most intense, which is generally between December and March, heavy and continued gales very frequently prevail, which commonly proceed from between the North and West, across the course of the stream, from Cape Hatteras until past George Shoal, and bend its direction to the eastwards; being aided at the same time by the discharge of the great bays and rivers, increased by the force of the wind blowing down them, and the constant supply of stream that passes along the coast of the Carolinas, the whole produces so strong a current to the eastward as to render it impossible for a ship to approach the coast until a change of wind commences.

During the prevalence of a southerly or easterly wind, which is not so common here, it has been found that the current is forced close to, and in some parts upon, the edge of soundings; being thus pent in between the wind and the shoal grounds near the shore, the breadth is greatly diminished, and the velocity proportionately increased. This circumstance has been in particular observed from about the longitude of Block Island, along the edge of the Nantucket Bank, thence beyond George's Bank, and also along the coasts of Georgia and part of South Carolina. In the first instance, that the southerly winds forced the current to the edge of soundings, where it then ran from $1\frac{1}{2}$ to 2 knots; and in the latter instance, that the easterly wind forced the current upon soundings. With West and N.W. winds, the stream would be removed some leagues further off.

From what has been said, it is clear that the eddies about the edges of the stream must vary according to the circumstances above explained. Along these edges, but more particularly along the outer edge, there is generally a current in a different direction, which is accellerated by the wind in proportion to its strength, blowing contrary to the stream, and retarded, and perhaps altogether obstructed, by the wind blowing in the

direction of the stream. In the latter case the limits of the stream will be extended.

(295.) **The Channel of the Gulf Stream.**—The peculiar and dangerous character of the shores of the Gulf, and the necessity which existed for the establishment of some means of averting the mischief it annually occasioned, led to a minute examination of its features so geologically and geographically interesting, which has been made practically useful by the erection of a fine line of beacons and the necessary lighthouses upon the Florida Reefs.

Professor Agassiz, who investigated this subject, has shown that the Florida Kays and Reefs are essentially of coral formation in various stages of existence. At Kay West, the basis of this is shown to be a coarse oolitic rock with cross stratifications, and dipping at various angles in different directions. The formation of coral upon this rock extends not only over the Kays, but also to the main land of Florida, and by a careful process of inquiry and reasoning it may be inferred that a very different order of things existed at no very remote period of the world's history.

We have a peninsula—a narrow, flat strip of land, projecting for about 5 degrees from the main land, between the Atlantic Ocean and the Gulf of Mexico, and forming an effective barrier between the waters of the two seas, which otherwise, even by the change of a few feet in the relative level of the intervensng peninsula, would communicate freely with one another; and this peninsula we now know to have been added to the continent, step by step, in a southerly direction.

We know that the time cannot be far behind us when the present reef, with its few kays, did not exist, and when the channel, therefore, was broader, and the Gulf Stream flowed directly along the main range of kays. We know, further, that at some earlier period the kays themselves were not yet formed, and that the channel between Cuba and Florida was wider still, washing freely over the grounds now known as the mud flats, between the kays and the main land, and that there was then nothing to impede a free communication between the Gulf of Mexico and the Atlantic Ocean.

If it is true that the Gulf Stream and the south-west winds have an influence in determining the course of the isothermal lines upon the two sides of the Atlantic, and of raising beyond their normal altitude the mean annual temperatures of north-west Europe, then we may look to the physical changes which have occurred on the south-eastern extremity of the North American continent for the cause, or at least a partial cause, of those changes of temperature which have taken place in the beginning of the present period, in those very north-western portions of Europe which are now so much warmer than the corresponding latitudes on the American continent, and which, soon after the accumulation of the glacial drift, had as low mean annual temperature as the coasts of Labrador, Nova Scotia, and New England in our day.

The present condition of the Florida country then is this:—On the outer edge we have "*the reef*," a submerged line of danger to the navigator, which rises nearly to the surface of the water, on which every variety of coral life is developed. It follows the line of Kays within it in a perfectly parallel curve, and forms the boundary to the Ship Channel inside it for hundreds of

miles. Upon this line and space are small patches which rise above the surface, of course of dead coral, and upon these is gradually heaped the *debris* of the reef, in the form of sand and broken coral, till it attains a permanent level above the surface. Within this reef is a channel which has a depth of from 2 to 7 and 8 fathoms, which, with care and some knowledge, may be navigated, and which has various openings to it through the reef.

These Kays consist generally of coral boulders and the fragments of coral and shells heaped up by the action of the waves, and which have become agglutinate by some obscure process, till they become firm land, not by the upheaval of old coral growths, but by the action of a stormy sea and tremendous waves. They are generally level, and it is only at times that the water rises sufficiently to account for their elevation. On page 397 (278) is an instance long recorded of an extraordinary rise in the waters.

In the year 1846, the water rose eight and a half feet above high-water mark at Kay Vaccas. Kay West was entirely inundated during the same gale; and though that island is somewhat protected by the reef, at present the rushes, driven upon it by the flood, may be seen among the trees and bushes, at a height almost equal to its loftiest summit. In 1841 the water rose ten feet above high-water mark at Cape Romaine, on the western shore of the peninsula.

This brief notice must suffice on this head. Proceeding still further northward, we find an important result of the operation of the Gulf Stream, in the formation of the range of the Sea Islands of Georgia, so famous for the growth of its peculiar cotton. These low alluvial deposits are the results of gradual accretion still going on, which affords a genial soil for the cotton plant, while the tepid waters of the Gulf Stream, which rush past them, tempers the easterly winds which blow on this seaboard, and add their important influences to the peculiar growth of this cotton plant.

(296.) Recapitulation.—We have thus described this famous stream, perhaps at greater length than is needed, from its origin in the Mexican Gulf to the offings of Cape Cod and Nantucket, a portion of its course much better known than any other, and easy of definition, which is not the case with its further progress.

It has been shown (265) that, between the Tortugas and Havana, it is only about 40 miles wide, and not 1,200 feet deep, travelling with a mean annual velocity on the surface of 32·7 miles per day, as was previously estimated in this work, or of 30·7 miles as calculated from the Board of Trade charts, which will always be preferred.

Passing onwards to the Narrows of the gulf between the Bemini Islands and Cape Florida, distant 330 miles from the first section, we come to that part which, beyond contradiction, decides the whole character of the Gulf Stream, as the *whole of it* passes over this OUTFALL. It is here 39½ miles wide, and the water above the temperature of 60° is about 1,200 feet deep in the centre of the stream. The *sectional area* of the stream in this part is therefore about 6·64 square miles.

Its *velocity* was calculated, in former editions of this work, to be about 65·4 miles per day on an annual mean; but the much more exact data of the Metecrological Department (1872) gives an annual mean of 48·0 miles

per day. (In *Spring*, 43·6 miles; *Summer*, 45·1 miles; *Autumn*, 46·8 miles; and *Winter*, 53·4 miles per day); which is contrary to previous calculations. These figures accord very well with those which result from the calculations made for the Tortuga-Havana section.

Now, as the inference is that the cold substratum of the Gulf Stream is moving in a direction opposite to its course, that is, *southwardly*, there is some point where there is no movement. Making all possible allowance for the decrease in velocity from 48·0 miles on the surface to 0·0 at the bottom (and this must be done in an empirical manner, and may be *much* overrated) the mean velocity of the whole mass will not exceed 36·25 miles per day. The sectional area of the stream not exceeding 6·64 square miles, it follows that there are not more than 240·7 cubic miles of water passing per day over a given line in this part of its course.

Its mean rate of progress, when passing Cape Hatteras, is given as nearly the same as in the Narrows, 47·2 miles per day, though this is in excess of the velocities given at intermediate points. The surface water will take 13½ days to pass from Cape Florida to Cape Hatteras, 630 miles apart; but if the whole mass maintains the same rate, it will not pass over under 17 days, and will be at the annual mean, only 4°.2 Fahrenheit cooler (varying from 10° to 1°·2). Off New York, it will be 10° cooler (varying from 17° in winter to 3°.9 in August). Off Cape Hatteras the breadth of the stream is 120 miles, therefore it has expanded to a breadth of more than three times (3·3) its width at the outfall, and its whole mass will make a bed of water 366 feet thick.

From this line to that of the section running S.E. of Nantucket, the distance is about 480 miles. On and near this section temperature soundings were taken by the U. S. coast surveyors, Commander Craven in 1354, Davis in 1845, and Bache in 1846, and their observations place us in a difficulty; for the warmer waters were not found to exist northward of the parallel of 38° N.; the "cold wall" showed itself to the North of this, and then two less warm beds as far as 40° N. But the observations for current motion show its eastern progress much further than this, in fact up to 41° N. If we accept the lower estimate of its rate made by the Meteorological Office (as should be done), it will take 16 days to move the whole mass from Hatteras to Nantucket, or 33 days from the Outfall. Its temperature has only reduced from 12° to 18° since it left the Gulf of Florida. It is this rapid course and consequent preservation of its original warmth, that has made it so remarkable in all ages.

But while it has thus carried the tropical heat so near to, and amidst the Arctic cold, its volume must be spread over a very much wider space, for its somewhat undefined breadth off Nantucket may be assumed at 300 miles, or seven times its original breadth; and if its velocity throughout were equal, it could only be 170 ft. deep, but as its rate has somewhat diminished it may be taken as 200 ft.; but then its surface has much cooled down, and the body of *warm* water cannot be assumed even as high as this calculation makes it.

(297.) This brings this wonderful current down to the new phase of its character. Hitherto it has been a rapid heat-bearing stream, pressing on to the American coast, beyond the usual limits of where the division lies in

other oceans between the westward tendency of sea and air within the tropics, and the eastward movements of extra-tropical latitudes. Henceforth it leaves the coast on a due eastward course to the South of the great collection of banks which lie of the British American possessions, and this portion of the stream will be considered in the next pages.

(298.) **Eastern Extension** between about 68° W. and 48° W.:—In examining the condition of the Gulf Stream, in the next 850 miles, we encounter many difficulties. Its physical features, the interferences it encounters, the opposing streams which neutralize its onward course, and the ever-varying rate of its current, have all to be taken into consideration. By confining the observations to those made, in the summer season, by the U.S. officers, off Nantucket, and to the current observations integrated by the Board of Trade, it might almost be inferred that the Gulf Stream ceased between Nantucket and the S.W. part of Nova Scotia; for while the first makes the whole bulk of its warmer water to lie *South* of lat. 38° hereabout, the current observations show no eastward drift to the *northward* of that parallel in the same region. But the varying easterly drifts, and the generally much warmer water which is found than is due to the latitude, will point to its origin. By the rapid transport of heated water into these regions by its northern course, one feature is brought into existence which has not been sufficiently considered—that of the fogs which characterises the whole section now to be considered. The Nova Scotia and Nantucket Bank, as well as the Newfoundland Great Bank, is proverbially a region of dense mist. The cool winds condense the evaporation from the warm Gulf waters over thousands of square miles; and this process, as is well known, is one of the most effective methods of cooling that can be imagined.

In addition, therefore, to the inter-mixture of an enormous bulk of Arctic water* in this part of its course, it has the no less attractive atmospheric agents at work on its surface in bringing down its waters to less than the normal temperature due to the latitude. The area, always more or less enveloped in fogs, and densely so when the prevalent N.W winds blow, is not less than 20,000 square geographic miles in the offing between Nantucket and the Grand Banks, and this is leaving out of the reckoning all the other areas subject to the same chilling influences.

H.M.S. *Challenger*, in her deep-sea exploring expedition, twice crossed the course of the Gulf Stream in its eastern portion, and Sir Wyville Thomson remarks that where they crossed it about 250 miles eastward of the Chesapeake, the stream was 60 miles in width and 100 fathoms deep. We presume that he considers that the stream had a river-like appearance to this extent. It may be interesting to quote the temperatures at different depths.

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* Com. W. Chimmo, R.N., in 1868, found that the Arctic current swept the rocky bottom bare on the Grand Bank and on the Flemish Cape, at the depth of 250 fathoms. He also found that the under stratum of cold water was universal, and that the Gulf Stream was very superficial; thus, in lat. 44° 3′ N., long. 48° 7′ W., which would be in the main strength of the stream, while the surface was temperature 61°; at fifty fathoms it was 43°, or 18° colder, and this in July. See Proceedings of the Royal Geographical Society, vol. xiii.

Temperatures observed in crossing and recrossing the Gulf Stream by H.M.S. Challenger, April and May, 1873.

Position of Ship.	Bermudas towards Sandy Hook.					Halifax towards Bermudas.				
	34° N. 67½° W.	36° N. 70° W.	36½° N. 72° W.	37½° N. 71½° W.	38½° N. 72¼° W.	42° N. 63½° W.	41½° N. 63¼° W.	39¾° N. 63¼° W.	36½° N. 63½° W.	35° N. 64° W.
At the Surface ..	65	65	75	52	50	47	59	67	72	71
50 fathoms	64	65	—	52	—	—	—	—	62	—
100 „	64	65	65	49	51	45	55	65	64	65
150 „	64	64	56	44	—	—	—	—	64	—
200 „	64	63	52	42	43	41	47	64	64	64
250 „	63	63	49	40	—	—	—	—	—	—
300 „	62	63	47	39	40	38	42	61	60	62
400 „	56	56	—	39	39	38	39	52	54	55
500 „	48	47	42	38	—	39	39	46	45	—
1000 „	—	—	38	—	—	37	37	—	—	—
1500 „	—	—	37	—	—	36	36	36	36	—
Bottom	35 (2850) fms.	—	—	35 (1750) fms.	36 (1240) fms.	37 (1250) fms.	35 (2020) fms.	35 (2800) fms.	35 (2650) fms.	— (2650) fms.

Taking a general view of the temperatures between St. Thomas and Halifax (each of which places lie on about the same meridian as Bermuda), it is to be noticed that the surface temperature gradually increases to the northward and southward of Bermuda; to the northward by reason of the warm water of the Gulf Stream, till a maximum of 72° is found in 36½° N.; and to the southward by reason of the lower latitude and the Equatorial currents, until the surface temperature is found to be 79° at St. Thomas. Below the surface, however, a state of affairs is found to exist as follows:—100 fathoms below the surface at Bermuda a temperature of 66° is found; at St. Thomas, 70°; in 36½° N. At 200 fathoms—at Bermuda, 63½°; at St. Thomas, 63°; in 36½° N. to 40° N., 63°. At 500 fathoms—at Bermuda, 46½°, which temperature continues the same to 40° N.; but at the same depth, in proceeding to the southward, the temperature gradually decreases till at St. Thomas it is only 43½°, or 3° colder than that found 21 degrees of latitude to the northward. This, although a small difference, must be due to the effect of the Gulf Stream. Proceeding to the eastward from Bermuda, towards the Azores, the temperature of the surface water decreased gradually, and that at 500 fathoms remained pretty constant at 46½° for 700 miles.

The *velocity* of the Gulf Stream in the section now under consideration is very various; but, as a mean, has been placed at from 26 to 36 miles per day. If this estimate is reduced from more exact observations, as has been done in the course of the stream to the S.W., these figures must be placed at about 20 or 27 miles respectively, and it would thus take about forty days to bring the stream from Nantucket to 48° W., a distance of about 850 or 900 miles. This would make a period of 72 days from Florida. But all calculations on this head are very vague, as we do not know the

relative velocity of various parts of its stream, and nothing of that at a short distance below the surface.

The *limits* of the stream have now become a subject of great difficulty. Formerly it was thought that its waters flowed eastward as far South as lat. 36° or 37° between longitudes 65° and 55° W., but with a feeble current, and are so marked on the Admiralty Pilot Chart of 1868. But in the Board of Trade Monthly Charts of 1872 there is positively no evidence of an easterly set to the southward of lat. 39° beyond longitude 60°. This adds very much to the complexity of the problem of how the warmer waters can possibly reach the coasts of N.W. Europe, as is strenuously claimed for them. The northern margin is known to be in a continual struggle with the Arctic current, which sets in an opposite direction to its course with about an equal velocity; and, therefore, a mere verbal account can give but little definite information.* With this uncertainty about its limits or existence in some parts, it is evidently difficult to estimate its breadth; but, according to the generally received extent, it may be about 300 or 350 miles on the meridian of 48° W., a most vague amount, but which makes it about eight times the breadth that it was in the Narrows of Florida; and, as its mean velocity is less than one half of what it was at the commencement, it follows that the whole body of water passing Florida will not be more than 20 or 25 fathoms deep over such a line; and, as its temperature is lower on the surface at the eastern part of the course in question than it was at its commencement, it follows that the film of *warm* water it sends up here cannot be more than a few inches in thickness. The area supposed to be covered by it between Nantucket and long. 48° W. is not less than 280,000 square miles; and, therefore, 239 cubic miles poured over this per diem will make a stratum of 5.15 ft. thick per diem. Further, it may be said that thus far it receives *no tributaries;* every observation on the surface recorded negatives such a supposition.

Temperature.—There is one singular fact—elicited by later researches, and by a comparison with the Current Charts of the Meteorological Office—which is, that the main body of the warm water, which has been traced along the United States' coast, bears off in a due easterly course southward of the parallel of 38° N.—that is, directly across the ocean (not on a great circle course, but to the southward of it) toward the Strait of Gibraltar; and this, too, where there is not the *slightest evidence of an easterly current* on the monthly or annual mean chart of the currents. This is very remarkable, and well deserves attention from those who study the distribution of Ocean warmth. There can be no doubt of the fact, since Maury, Rennell, Andrau, and the Meteorological Office, all agree on the point.

(299.) The late Dr. Petermann, who gave an immense amount of study to the subject, has drawn up two charts to illustrate his views. They are taken from the mean values of Maury's and other charts, and are for the months of July and January. On the July chart, the core of the Gulf Stream

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* At times the change from warm to cold surface water is very marked. Commander Chimmo found it change, in going northward, from 72° to 58° in 2½ hours.

(Kern des Golfstroms) shows the form of a tongue, of a temperature of 81.5° (at some places even 84° was observed), extending North of the Equator to the 38th degree of latitude. This may be called not only a warm, but, better, a hot stream. This hot stream produces itself as a double tongue, with a mean temperature of from 77° to 81.55° towards the North as far as the 40th degree of latitude (in one spot only), and toward the East to the 43rd degree of longitude; that is far beyond Newfoundland. In January, the tongue of 77° reaches to lat. 37° and long. 70° 30′ W., and at the place where the East end of this tongue of 77° terminates in July, we find in January a temperature of 63.5° and 65.8°.*

To this it may be added, that the East end of the tongues of warm water above mentioned are 300 miles South of the southern edge of the Gulf Stream, as usually placed; and, as stated before, in a part of the ocean where no easterly stream is felt.

The evidences of this portion of the Gulf Stream being much warmer than is due to the latitude, are much qualified by a reference to the Temperature Tables of Lieutenant Andrau, drawn up for the Netherlands Meteorological Institute. For January, the latitudes of these two "hot tongues" are 36° N. and 33° N. respectively. On taking the figures lying between these paralells, they show thus, premising that each temperature is given for the mean between each meridian 5° apart; the first being from 50° —45° W., the last to the right hand 20° to 15° W.

Lat. 36°	—	—	63.7°	62.6°	63.1°	—	61.2°
Lat. 33°	69.3°	65.8°	65.8°	65.7°	66.4°	—	63.9°

These figures show that the temperature is very uniform nearly across the ocean, and they accord almost exactly with those of our Meteorological Office.

For July, the hot tongues are in the latitudes of 38° and 34° N., and the figures show a similar result; and from this it would seem that the main bulk of the hotter waters of the Gulf Stream is lost in mid-ocean, about the meridians West of 45° W.

It is, therefore, safe to affirm that Rennell was correct in his statement, that the portion of the stream to the southward of lat. 40° (he says 42½°), and long. 40°—30° W., drifts with an almost imperceptible surface movement, until it is lost in the neighbourhood of Corvo, where its temperature and attributes do not vary from those portions of the Atlantic manifestly far away from its influences.

(300.) It is with the northern portion (North of lat. 40° N.) of the Gulf Stream, then, that we shall have to deal in its future course eastward, and this is very much cooler than the hot core above adverted to. On the meridian of 50° W. the water in July is at a temperature of 70°, on the parallel of 40° N., and is only 45.5° at 300 miles to the northward. In January these figures stand at 61° and 34° respectively, and thus in these 5° of latitude the water becomes cooler by 24.5° and 37°; and, looking

* Mittheilungen, 1870, page 219; and Knorr, pages 42, 43.

generally at the isothermal lines, it would seem as if they were crowded to the southward by the land and the influence of the Arctic Current.

Arrived at the Grand Bank of Newfoundland, we encounter a totally new feature in its condition. It here encounters the full force of the Labrador Current, which, setting southwards over the Banks with nearly equal velocity and bulk, cuts off the eastward course of the Gulf Stream in all that part of the current which runs North of 42° or 43° N. The isotherms, derived from the immense mass of figures in Maury's thermal charts, show, as Dr. Petermann says, that the Polar waters set against and penetrate it like an immense wedge.* This cold water gulf penetrates for 150 to 200 miles southward of its general limit; and in July, which is the period when the Arctic ices drift down in the greatest quantities, this is most evident, as the Arctic water is not more than 48°, while that of the Gulf Stream to the southward is 68° and upwards. In January, the period when the Arctic regions are entirely frozen, and no icebergs descend into these southern latitudes, the effects on the surface are not quite so manifest, but are equally evident as far South as lat. 38° N.

Now, this "cold water gulf" is no surface interference of a temporary nature. It is a strong permanent current, flowing to a greater depth than the Gulf Stream at all seasons of the year. That it entirely cuts off all the lower beds of the warmer water is demonstrated by the fact, stated on page 438, that icebergs, 80 and 100 ft. high, have been seen as far South as lat. 36° 10′ N. in April, 1829, and 38° 40′ in June, 1842. This shows that the more powerful southern Arctic drift, of which many evidences are constantly met with in the summer months, by the ice drifts, and in the winter by the cold water, must cut off the eastward progress of this northern portion of the Gulf Stream waters. But it is very probable that a small portion of the warm water does get over to the eastward of this in "hot streaks" which are so remarkable; because, although the thermometer on the surface shows that there is no continuity in the waters on the East side of long. 48° with that to the West of that meridian, yet the current observations show that the drift is still, generally, to the eastward.†

Up to this point we have said nothing about the speculations that have been promulgated respecting the heat bearing properties of the Gulf Stream; but, in this book, space will not allow us to enter upon them. Those of Mr. James Croll, however, must be noticed, as they refer to a method of estimating this by the powers of absorption of the sun's rays by the ocean's surface, represented by the dynamic enumeration of foot-pounds. But I would deferentially demur to its calculations. He takes no account

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* Mittheilungen, 1872, page 220; Knorr, page 43.

‡ It is quite certain that the surface motion is not of any great depth, and that at a few fathoms beneath the surface it is inappreciable to any ordinary mechanical means. There is direct evidence of this in the deep sea sounding trials, and more especially in the electric cable laying experience. In these, if there should be any under currents of force, or in different directions, it would be shown directly by their action on the submerged line. In the case of the Electric Telegraph cables, the refined dynamometric apparatus employed is, generally, so uniform in its evidence, that the question of sub-surface action may be said to have been settled by it.

of the time it takes for the water to circulate, or of its ascertained depth. He very much exaggerates the known volume of the stream, and does not refer to the interferences it encounters, the fog banks, nor of the Labrador Current. However valuable his suggestions may be, they must be applied in a different way.*

(301.) Having thus brought the Gulf Stream through its remarkable and well-defined course, which on its northern margin is not less than 3,500 miles, we arrive at the conclusion, which is here repeated from our former editions, *that its further progress as a distinct current cannot be traced.* It merges into the general ocean drifts common to the sea for many hundred miles on either side of it. This conclusion is in antagonism with that of many who contend for its extension and evidences up to the shores of N.W. Europe, and into the Arctic basin. But while the facts on which this conclusion is based are not for one moment questioned, yet their connexion with the stream which has thus far been described is not shown, and the effects claimed for it are so immeasurably greater than the parent source, that they must be inevitably referred to much more powerful causes. These will be briefly discussed in the ensuing section.

8. NORTH-EASTERLY SET TO WESTERN EUROPE, ETC.

(302.) The previous pages have brought the Gulf Stream up to the meridian of 50° or 48° W. The southern portion of the eastward Current, that southward of lat. 40° N., passing over towards the Azores, with the other drifts, forms the head of the North African Current (183), while the portion North of that parallel ceases as a heat-bearing stream on the same meridian. Its further progress is manifestly entirely cut off by the very much deeper Arctic Current; and this is the case throughout the year.

But it is contended by Dr. Petermann, that as the ocean becomes suddenly warmer to the eastward of the meridian of 48°, and this, too, for an extent of not less than 300 or 400 miles in a N.N.W. direction in July, or N.N.E. direction in January, as shown by the direction of the isotherms, this warmer water must be the Gulf Stream.† Undoubtedly, looking only to the direction of the isotherms, there would seem to be grounds for this assertion; but the positive fact that the Polar Stream entirely intersects it, and that there is not the *slightest evidence of any northerly set* to the East of the Great Bank (on the surface at least) precludes such a supposition. The *eastward* course of the surface waters is continued alike over the colder as

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* See "Geological Magazine," vol. vi., April 1869; and "Philosophical Magazine," February, 1870.

† "It is by no means annihilated (by the Polar Stream); on the contrary, it sallies forth intact from the conflict." Again: "The Gulf Stream is not disturbed to any degree, either in its direction or in its temperature, until a very short distance East of Newfoundland, when it bends sharply round to the *North*."—Mittheilungen, 1870, page 220· Knorr, pages 43, 44.

over the warmer areas; and as the surface temperature we are discussing must be dependant in some degree on surface motion, there must be some other great agent at work to produce this effect. How this operates is not clear; and, like many other mysteries of the ocean, it awaits an explanation it is certainly not caused by surface current.

Looking at the general arrangement of the isotherms, it would seem as if the waters of the ocean South of the parallel of 45° or 50° N. latitude, and eastward of the 40° meridian, were at their normal temperature, and that it was the effect of the Polar Stream and the arrangement of the land on the western side of the ocean that broke up the symmetry, by forcing the warmer waters several degrees of latitude southward of the position they would occupy but for this combination of causes.

The rate of the drift is from 6 or 10 miles to 20 or 24 miles per day; and as far as 50° N. it seems generally to flow due *East* towards the French and Portuguese coasts, and thus forms the head of the temporary Rennell's Current. But, singular to say, observations are not abundant hereabout, and the true rate can only be given approximately; it is of no great power, and has but little effect on a vessel's course. Beyond the doubt, whether the water thus far can be considered as the Gulf Stream, there is no controversy as to this part of the ocean circulation.

(303.) It is to the N.E. of this that there is a difference of opinion. It has been generally believed in former times, that the climate of the western portion of the British Isles, that of Norway, Iceland, and a large area around the northern part of Europe, was dependent on the Gulf Stream, which flowed continuously throughout as a heat-bearing current; but this cannot now be maintained, since we have been made so intimately acquainted with the dimensions and character of the stream in its greatest strength.

(304.) **Bottles.**—The observations for its velocity and direction are not very numerous; and, therefore, we have recourse to the drift of floating bottles, about which much controversy took place, at the time they were collectively brought forward in the "Nautical Magazine," in 1853. As they tell a singularly consistent tale, which is entirely confirmed by similar experiments in the southern hemisphere, their testimony must be brought into the question. See (166) p. 313, *ante*.

The following statement of the drift of bottles is derived from Captain Becher's Bottle Chart. Many of the particulars contained in it have been given in our former editions, but they are here given entire in order that an estimate may be formed of the strength of the current in which they have drifted. It may be premised that the length of their courses is given in the shortest or direct distance. It therefore underrates their progress, as they have doubtless not generally pursued the shortest track to their destination:—

These bottles, taken from Captain Becher's list in the "Nautical Magazine," 1853, have been selected from those which have made the ordinary drift. The chart which shows their direction points most clearly to the eastward and north-eastward drift, although the rate is not high, being for the above 6·6 miles per day, which is probably below their actual rate.

Ship.	Signature.	Where left.			Where found.	Interval Days.	Distance in Miles.	Rate per day.
		Year.	Lat. N.	Long. W.				
			°	°				
Osprey	McGill	1822	49.6	12·5	Wales	36	270	7.5
Wallace	Robertson	1835	52.2	15.0	Ushant	130	450	7.2
Tyne	R. Hope	1834	46.6	16.9	Devon	71	600	8.4
Kent	W. L.	1836	50.3	19.0	Boulogne	126	890	7.0
Niger	Merret	1839	48.2	18.9	Quiberon	177	700	4.5
Bolivar		1840	46.9	18.6	France	94	700	7.0
Mary	Lock	1832	44.2	18.0	France	310	700	2.2
Ibbetson	of Stockton	1826	55.5	18.3	Killala	59	300	5.0
President	Scott	1836	48.5	19.6	France	128	650	4.1
Virginia		1838	42.2	19.3	Cork	45	750	17.0
Persian	Mallard	1834	47.1	20.4	Ireland	113	600	4.1
Albert	Robertson	1822	47.3	21.9	Somerset	186	820	4.3
Ardent	Duncon	1824	57.0	24.5	Lewis	171	610	3.6
Superior	Munson	1842	53.8	24.0	Dunnet Head	175	800	5.0
Enterprise		1833	45.1	24.3	France	316	980	3.1
Mary	Godfrey	1840	47.3	27.4	Clare Island	111	850	7.7
Orbit	Boot	1811	46.8	27.0	Ireland	330	860	2.7
Romulus	Crawford	1819	57.8	30.7	Shetland	110	1000	9.1
Helen	Butman	1834	47.3	33.6	Scilly	179	1150	6.4
Sandwich	Squire	1821	50.3	36.4	Hebrides	184	1100	6.3
J. Cropper	Marshall	1824	48.3	38.1	Mounts Bay	398	1230	2.4
Seine		1811	50.7	40.3	Kerry	274	1130	4 5
British Queen	Hamilton	1838	43.9	44.5	Newport	66	1700	25.7
Royal Union	Grant	1822	48.2	45.2	Scilly	75	1450	19.9
Elizabeth	J. E.	1819	47.0	49.2	Rathlin Isle	311	1600	5.0
Victoria		1834	45.0	50.0	Lands End	215	1760	8.2
Alexander	Parry	1818	59.1	52.3	Staffa	437	2400	5.5
Alexander	Parry	1818	62.0	54.0	Donegal	416	2600	6.2
Newcastle	Napier	1819	38.9	64.0	Ireland	356	2700	7.3
J. Esdaile	King	1821	36.9	71.8	Lancashire	495	3000	7.0
R. de Holland	Groeneld	1850	46.0	20.5	Glandore	345	680	2.0
Jessy	Cook	1846	50.6	20.5	Brest	59	480	8.0
	Johnstone	1847	47.3	21.7	Brest	206	700	3.5
Delia	Adey	1842	50.0	26.0	Ireland	138	600	4.6
Normandie	Spalding	1844	57.1	33.2	Norway	228	1400	6.1
Graham	Beach	1847	51.1	45.5	Barnstaple	233	1560	6.7

It will be observed that the velocity of the drift varies greatly, a long course having been performed at a mile an hour and upwards, while in other cases their progress would be inappreciable in the navigation of a ship.

There is a very marked feature, that of their eastward, and not north-eastward tendency, as might be inferred from the prevalence of the S.W. winds.

(305.) Of this eastward tendency of the waters on the eastern side of the Atlantic there can be no doubt, and this is the great question to be elucidated, but which, from its great extent, cannot be discussed here, as it is foreign to the purpose of this work. This fact is manifested by abundant proofs. Besides the greater warmth of the water, which diminishes as we proceed westward, there are tropical products, such as seeds (the beans of the mimosa scandens, cocoa-nuts, &c.), which are frequently washed ashore at the Færoe Islands, Iceland, Norway, &c., all proving a south-westward origin.

(306.) The arrangement of the isothermal lines on the ocean N. of 45° or 50°, as shown by Dr. Petermann's charts, as well as by all other physicists, show that a great change occurs in the static condition of the water North of lat. 50° throughout the year. Instead of the lines of equal temperatures running East and West, they have a N.E. and S.W. direction, nearly to Spitzbergen. On referring to the wind diagrams given at pp. 229-231, it shows that the winds hang generally to W.S.W. or between S.S.W. and W. by N.; and as these south-westerly winds have the greatest force, they have the greater effect on the climate of the countries under their influence. But when it is known that the water is warmer than is due to the latitude, to a depth perhaps of 500 or 700 fathoms, it is a manifest impossibility that the anti-trade wind can be the transporting agent.

In the absence, then, of any clearly assignable cause for this elevation of the temperature, it must be considered *that the whole body of the ocean-water on the eastern side of the Atlantic is drifting to the northward.* To assign this cause to the Gulf Stream is to ignore the statistics of the stream; and it is again affirmed that this very marked stream-current should have a distinct designation.* As the area which is now claimed to be raised in temperature by the Gulf Stream far exceeds 1,500,000 square miles, it follows that the quantity of water which passes along the American coast, which can reach it, cannot cover it to a greater depth than 6 inches per diem, and this after a period of one, two, or perhaps three years,† through the fog-banks of N.E, America, and through the Labrador Stream.

(307.) As Dr. Petermann, by his valuable labours, has thrown more light than any other author on this remarkable and interesting stream, which he contends is the extension of the true Gulf Stream, we quote his words as to its influence on N.W. Europe, &c.

"While the (Gulf) Stream has in January, on the 50th parallel of latitude, still a temperature of 54.5°, the thermometer shows at the same time, at Prague or at Ratibor (in Silesia), on the same parallel of latitude, temperatures of 24°, and sometimes still lower ones. (There can be no comparison between land and ocean temperatures. The immense influences of radiation and evaporation, or deposition, between the two conditions, render them quite incongruous. There is no better evidence of this than in the climate about the North Cape. While the sea around it in January has a temperature of 36°, that of the land is sometimes—24° and 26° below zero, a difference of more than 60° of temperature, and this is clearly owing to the direction of the wind, which, as Mr. Buchan shows, prevails from the

* A singular argument about its rate has been adduced. General Sabine, when at Hammerfest, in 1823, saw some palm oil barrels drift ashore, being (as was supposed) from a vessel wrecked at Cape Lopez, in the preceding year. Therefore, these barrels had been drifted by the Gulf Stream from Florida, not in one or two years, but in *two months!* From the well-known velocity of the stream in its different parts, they must have passed through the Straits of Florida, &c., at the rate of *seven hundred and ninety miles per day.*—Mittheilungen, 1870, p. 241; Knorr, p. 85.

† Dr. Petermann suggests that the term "Gulf Stream" should be used for this European current, and that the true stream should be called the "Florida Stream." But this is reversing the argument. The real Gulf Stream has been thus known from the earliest times, and the term has only been applied of late years to the European current.

S.S.E.*) The isothermal line of 54.5° (10° R.) runs up in July toward Iceland and the Færoe Islands to the 61st degree of latitude. There it meets for the second time the Polar Stream, which on the East coast of Iceland again threaten to block up its way and to destroy it."

The summer observations of temperature collected by Admiral Irminger, of the Royal Danish Navy, has thrown great light on the important question of this warm water extension. His conclusions are based on the observations he zealously collected from the voyages of the Danish vessels going in the summer season between Denmark, the Orkneys, and Greenland.†

"As already noticed, an arm of the Gulf Stream proceeds towards the North along the West Coast of Iceland, and this arm extends to the East along the entire North coast, and does not meet the Polar Stream until it has reached the N.E. end of the island. Only for the months of May, June, July, and August, figures are found in Irminger's collection off the North Coast of Iceland, all of which show a higher temperature than those off the East coast. In July, temperatures were observed on the North coast of 45.0°, 47.1°, and 49.3° (Lord Dufferin, 46.0°), while off the East coast, for 6° of longitude, none higher than from 40° to 42.6° were found.

"Between Iceland and the Færoe Islands the Gulf and Polar Streams are contending against each other, and the result of this struggle is a sea divided in a great number of hot and cold bands, which fact is demonstrated clearly by Lord Dufferin's cruise from Stornoway to Reikiavik, in 1856, and fully corroborated by Dr. Wallich in the *Bulldog* expedition of 1860. The chart accompanying Dr. Wallich's memoir, has a very good representation of these currents.

"The fact that the two streams, in their contest, appear as many bands and strata, alongside, over and beneath each other, is proved not only by the observations of the temperature on the surface of the sea by Admiral Irminger and Lord Dufferin, but also by the researches of Dr Wallich in regard to the nature of the bottom of the sea. The latter found there volcanic stones pointing as to their origin to Jan-Mayen, and at other places ophiocomæ of two to five inches in length, which could have been carried there only by the warm Gulf Stream. Another argument is that the drift

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* There could be no better evidence of the fallacy of comparing a *land* climate with that influenced by the sea surface than this above quoted. The direction of this S.S.E wind, passing over some of the coldest plains in Europe, and probably also from great distances, has thus lowered its temperature to this extreme degree. A S.W. wind, on the contrary, brings, as may be readily inferred, the warmer influences of the surface it passes over. Therefore the ocean temperature, on the Western side of the Atlantic, has no manner of relation to the temperature of places many hundreds of miles inland, on its eastern side, although in the same latitude.

† Dr. George Forchhammer, Professor at the Copenhagen University, has given a very valuable paper "On the Composition of Sea-water in different parts of the Ocean." (Philosophical Transactions of the Royal Society, 1865, page 203, et seq.) And, by his extended researches, he has shown the origin of various branches of the ocean circulation. As regards that flowing around Cape Farewell from the eastward, he says, from its great salinity, 35·278 per 1,000, that it is very probably the returning Gulf Stream. At all events, it is *no polar current*, which will be easily seen on comparing it with the Baffin's Bay current, with a salinity of 33.281, or to the water North of Spitzbergen, 33·623.

ice penetrates here further to the South than anywhere else East of Iceland. Scoresby, for instance, in 1822, observed great masses of heavy ice in lat. 61° 30′ N., long. 7° 0′ W., and detached pieces even as far South as 63° 40′ N. (long. 8° W. of Greenwich), and as far East as long. 3° W. of Greenwich (in lat. 66° 49′ N.). Even still farther southward ice has been seen by Sir James Clark Ross, in lat. 6° 0′ N., long. 6° 0′ W., which is S.E. of the Færoe Islands.

"In the same manner the temperature of the sea at the Færoe Islands, even down to the Shetland and Orkney Islands, appears depressed in comparison with that of the West Coast of Iceland. The isothermal lines show from Jan-Mayen, a remarkable concavity as far as the North Sea, which can be caused only by the cooling influence of the Polar Stream. Reikiavik and Stykkisholmr (lat. 65° 4′ N.) have, in July, a temperature of the sea of 52.9° and 50°, while at Thorshavn, in 62° 2′ N., it is only 48.9° At times the temperature of the air also is, in consequence of this cooling influence, depressed from the Shetland Islands to the German coast.

"The mild weather of the British Isles is well known. The mean temperature for January at London is 37.4°; at Edinburgh the same; at Dublin 40.5°. The further we go from East to West or from South to North, or, in other words, the nearer to the Gulf Stream, the higher we find the temperature. At Unst, on one of the Shetland Islands, 560 miles North of London, the mean temperature of the air for January is 40.3°, and that of the sea even 45.5° (East Yell).

"A drift current, therefore, is out of the question, else the temperature of the air would be higher than that of the sea. Clearly, the warm current of the sea is tempering the air, and not *vice versa*. The lowest temperature observed in London is only —5°; at Penzance, on the West coast, +24.1°; at Sandwick, on the Orkney Islands, +15.8°; and at Bressay, on the Shetlands, +14.9°. At Madrid, +13.3° has been observed, and 27.5° even at Algiers, which provides Europe with the cauliflower in winter.

"While on the western side of the North Atlantic Ocean the Polar ice reaches down to lat. 36° N. (the parallel of Gibraltar and Malta), and the name of Labrador is sufficient to characterise the climatic qualities of all the land between 50° and 60° N., there extends on the East side of the ocean along the Norwegian coast, cultivated land up to 71° N., the northernmost land of the world in which, under the influence of the Gulf Stream, agriculture is the main occupation of the inhabitants. Wheat is grown up to Inderoën, in lat. 64° N.; barley up to Alten, in 70° N., where sowing generally is done between the 20th and 25th of June, yielding in the short space of eight weeks, to the 20th or 30th of August, on the average six or seven fold; the potato yields, at the same place, on the average, seven or eight fold—in favourable seasons, even twelve to fifteen fold; it thrives on the coast as far East as Vadsö, on the Russian boundary line. At Alten (70° N.) relishable cauliflower is raised even in less favourable summers."

(308.) On the vexed question of the influence of the sea on the climate of the British Isles much cannot be said here. In an essay, by Mr. Nicholas Whitley, C.E.,* he arrives at this conclusion respecting it. "Our S.W.

* See Proceedings of the Royal Geographical Society, vol. xiii, 1869, pp. 229 et seq.

wind has its birthplace where the temperature of the sea is at least 55° in January, causing the thermometer on the Cornish coast, under its influence, to stand steadily at 52°, and the great warmth of the past winter resulted from the continued persistency of this wind rather than from any excess of heat in the sea.

"The S.W. wind gives to Penzance a mean winter temperature of 44°, being the same as that of Montpelier; Cork falls short of it by only half a degree; and the Scilly Isles at this season exceed this noted winter resort by $2\frac{1}{2}$°."

In a further examination of the log-books of the Cunard steamers, sailing between Liverpool and New York for a period of five years, which results have been carefully tabulated, he says, "The extent and greatest intensity of the Arctic Current is sharply shown by the thermometer in every voyage. The cold water on the Banks of Newfoundland reaches its mean monthly minimum of 30° in January, and its mean maximum of 52° in September, and its width is fully 400 British miles.

"On the eastern side of the cold current, and in close proximity to it, there is a bed of very warm water, having a mean temperature in January of 50°, being 27° warmer than that on the Banks, over a width of about 200 miles. This appears to be a strong eddy of the Gulf Stream, curving northward, and holding the Arctic Current in its warm embrace.

"From this part of the sea to near the Irish coast the warmth is more equally distributed through the water, and the thermometer does not detect any well-defined branch of the Gulf Stream flowing to the N.E. There is, however, a decided rise in the temperature about the middle of the Atlantic, amounting to from four to six degrees above that of the sea at Scilly, and the figures on the chart appear to indicate that it lies in a S.W. and N.E. direction. It is most probably the drift of the Gulf Stream driven to the N.E. by the prevailing S.W. wind.

"The means represented in the table show that East of the cold water of the Newfoundland Banks (the Polar Stream, which has there a width of 400 miles, and a temperature in January of 30°, and in September of 52°), there is a warm bed of water, 200 miles in width, with a temperature of 57° in January and 61° August. Between this bed and the Irish coast the temperature is more uniform; there is, however, in the middle of this distance, in about longitude 25° W. of Greenwich, a belt of water of a decidedly higher temperature."

(.309) What has just been quoted refers to the S.W. coasts, carrying the views farther northward there is a very important meteorological paper of Mr. Alexander Buchan, Secretary to the Meteorological Society. "On the Temperature of the Sea on the Coast of Scotland," based on observations carefully collected from numerous stations, between January, 1856 and 1865, and the one great fact elicited, is given in the following:—

The great excess of the temperature of the sea over that of the air in the North is perhaps the most remarkable fact in the meteorology of Scotland. It is a difference, moreover, as the following table will show, which may be considered constant from year to year:—

	1857	1858	1859	1860	1861	1862	1863	1864
Mean annual temperature of sea at Sandwick ..	49.5	49.4	49.4	47.5	48.6	48.6	48.8	48.1
Mean annual temperature of air at Sandwick ..	47.5	46.0	45.7	44.1	46.3	45.8	46.4	45.5
Mean annual difference	2.0	3.4	3.7	3.4	2.3	2.8	2.4	2.6

This table teaches, if examined closely, the slowness with which changes in temperature of the air are completely propagated through the waters of the ocean in those northern parts where the power of the sun's rays is greatly diminished.

When the tendency of the temperature of the sea to follow that of the air is considered, it can scarcely admit of a doubt that, if the waters of the sea were stationary round Orkney from year to year, their temperature would ultimately fall to that of the air, or at least to about half a degree of it. But this is not the case; there is some influence at work keeping the temperature of the sea 3° above that of the incumbent air. The enormous amount of heat sufficient to maintain the whole waters of the sea in the North from 2° to 3° above the air, must be brought from warmer latitudes by currents of some sort or other. Since, then, a sea current from the South must be conceded, what is the agent employed?

Hitherto we have referred but very slightly to the movements or temperature of the lower strata of the ocean waters, but this very wide question has a most important bearing on our present subject. The very important investigations which were carried on in H.M.SS. *Lightning* and *Porcupine*, under the superintendence of Dr. Carpenter and Mr. Gwyn Jefferys. These will be adverted to in a special section at the end of this book; but, as connected with this portion of our subject, it may be stated that the voyage of the *Porcupine*, in 1869, demonstrated that there was a stream of warmer water 900 fathoms deep between Iceland and Spain, and equally as much near the Rockall Bank. Between the latter and the Færoe Islands it reaches to the bottom, or a depth of 767 fathoms, and at this the temperature is 41·5°.

These last facts are conclusive as to this movement of warmer water not being the Gulf Stream. By what possible reasoning can it be inferred that this can be the Gulf Stream, as it is nearly five times as deep, and hundreds of miles broader than that stream is at its origin; and, as it has been before shown, it receives no "tributaries." We, therefore, repeat the assertion that this great ocean current has a distinct origin, and should have a special designation.

We cannot pursue the question farther: it must be sought for in the numerous works bearing more especially on this subject, many of which have been referred to.

In a subsequent Chapter, this question with the surface and deep sea temperatures of this great current will be discussed.

In concluding this brief account of the most remarkable feature in ocean physics, we can only express the hope that the combined observations of the recent investigations will place this science of *Rheology*, as it may be termed, on as firm a basis as its cognate branches.

9.—THE ARCTIC, OR LABRADOR CURRENT.

(310.) The last section treated of the warmer tropical waters which passed into the northern regions, carrying with them the amelicrating influence on the Arctic climate. The present deals with the same waters as they emerge at a minimum temperature from these frozen regions, and bring their ice and cold into the grand system of circulation and compensation.

The limits of the N.E. drift about Iceland has been mentioned previously. To the West of this, then, we may place the great drift which comes down from beyond Spitzbergen, and transports the immense quantities of ice upon the eastern shores of Greenland, which has generally rendered this, one of the most inclement regions of the world, unapproachable by ships. Several instances of this drift could be recited, but as it is not interesting to navigation, they need not be dilated on. The ice this current brings into the low latitudes is an important consideration in the navigation of the Atlantic, as is well known. This branch of the Arctic drift, however, does not probably furnish many of those gigantic icebergs, which, drifting down Davis Straits, float over the Newfoundland Banks, and far into the northern margin of the Gulf Stream.

The estimated rate of this drift from Spitzbergen, calculated from the rate of vessels in the pack-ice, is from 8 to 14 miles per day.*

(311.) It was formerly considered that this S.W. stream, after passing Cape Farewell, the South point of Greenland, made direct for the coast of Labrador, and thence over the Newfoundland Banks. But Commodore Irminger, of the Royal Danish Navy, has demonstrated that it does not do so, but that it passes around Cape Farewell to the westward, and thence passes northward along the shores of West Greenland.

"If the current existed, which the before-named writers state to run in a direct line from East Greenland to the banks of Newfoundland, then the ice would likewise be carried with that currant from East Greenland; if it were a submarine current, the deeply immersed icebergs would be transported by it; if it were only a surface-current, the immense extent of field-ice would indicate its course,† and vessels would consequently cross these ice-drifts at whatever distance they passed to the southward of Cape Farewell. *But this is not the case*; experience has taught that vessels coming from the eastward

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* See Findlay, on the course of Sir John Franklin's Expedition, "Journal of the Royal Geographical Society, xxvi., 1856, page 33.

† "An observation which it is interesting to mention here, and which gives a proof of the very little difference between the temperature of the surface and that at some depth, is mentioned in the voyage of Captain Graah, page 21. He says, 'The 5th of May, 1828, in lat. 57° 35′ N., and 36° 36′ W., the temperature of the surface was found 6·3° (46·2° Fahrenheit), and at a depth of 660 feet 5·5° R. (44.5° Fahrenheit).' This proves that there is no cold submarine current in the place alluded to, to the S.E. of Cape Farewell. A still more conclusive experiment is recorded by Sir Edward Parry, in the account of his first voyage, June 23, 1819; in lat. 57° 51′ N., long. 41° 5′, with a very slight southerly current, the surface temperature was 40½ Fahrenheit; and at 235 fathoms 39°, a difference of only 1½°."—Ed

steering their course about 2° (120 nautic miles) to the southward of Cape Farewell, seldom or never fall in with ice before they have rounded Cape Farewell and got into Davis Strait, *which is a certain proof that there does not exist even a branch of the Arctic Current which runs directly from East Greenland towards the Banks of Newfoundland.*"*

The limits of this Spitzbergen Current, as it may be termed, is therefore indicated by the distance to which the ice it transports is found to extend, and the examples cited may be taken, as above, to a distance of 120 miles South of Cape Farewell, and to 150 miles of the Danish settlements of S.W. Greenland.

(312.) In the space of ocean between the southern limits of this current and the known south-easterly drift down the Labrador Coast, an anomalous condition seems to exist, we have no notice of the set of the streams, if any within it, but its characteristics seems to be the *drift-wood* within its area. These floating relics have evidently a southern origin, and point also to the truth of the statement that a warm current sets toward and past Iceland.

"Another proof that the current from East Greenland does not run in a straight line towards the banks of Newfoundland, is also derived from the observations of the temperature of the surface made on many voyages to and from Greenland.

"Supposing that the Arctic Current from East Greenland pursued its course in a straight line towards the Banks of Newfoundland, it would be crossed, on the voyages from Copenhagen to the Danish colonies in Greenland, between 38° and 45° W., and so high a temperature in the surface of the ocean as from 4° to 6° R. (41° to 45.5° Fahrenheit), as is found only on this route and marked in the plan, would, according to my opinion, be impossible only 1° or 2° to the southward of the parallel of Cape Farewell; as it is a well-known fact that the principal ocean currents maintain their temperatures through very considerable distances of their courses.

"This comparatively high temperature of the surface of the ocean so near to the limits of that current which carries enormous masses of ice from the ocean near Spitsbergen round Cape Farewell, warrants my opinion that the waters of the Atlantic Ocean move in a north-westerly, or northerly direction, towards the eastern and southern coasts of Greenland,† and that this in-draught towards the land is undoubtedly the cause of the ice being so closely pressed on to these parts of the coast as it is so frequently on the South coast, and almost constantly on the East coast, rendering the eastern coast entirely inaccessible from the seaward.‡

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* "Journal of the Royal Geographical Society," vol. xxvi., 1856, pp. 40, 41.

† Graah says in his Narrative (page 23, English translation):—"In the mouth of Davis Strait I found the temperature of the surface of the ocean from 4° to 3·1° R. (41° to 39° Fahrenheit), though we were in the proximity of the ice. From this I concluded that a current from the *South* predominated here, because I never before in the vicinity of ice had found the temperature of water exceeding 1·8° R. (36° Fahrenheit), and this conclusion was confirmed when, coming to the northward of the ice, I found the temperature of the water 1·1° *plus* R. (34·5° Fahrenheit)."

‡ Besides the evidence afforded by the ice-drifts and the temperature of the water, as cited by the author, conclusive proof of a northerly set is found in the drift-wood which

"From the foregoing it seems to me to be demonstrated that the current from the ocean around Spitzbergen, which carries such considerable masses of ice, after it has passed along the East coast of Greenland, turns westward and northward round Cape Farewell, *without detaching any branch* to the south-westward, directly towards the banks of Newfoundland.

"This current afterwards runs northward along the S.W. coast of Greenland until about lat. 64° N., and at times even up to Holsteinborg, which is in about 67′ N."—*Admiral Irminger.*

(313.) This current, then, after drifting over the Atlantic, passes up the eastern shore of Davis Strait to and beyond the entrance of Baffin's Bay, between Cape Walsingham and Holsteinborg. It here encounters the *southern* set which passes down Baffin's Bay, especially on its western side, transporting those immense icebergs which are annually launched from the glaciers of West Greenland and other parts, as described by Dr. Rink. This current, which enters Baffin's Bay, especially by Lancaster Sound, is the grand outlet of the waters which run from West to East through the labyrinthine Archipelago, once the scene of the exciting search for the expedition of Sir John Franklin, and is unquestionably the continuation of that drift past Spitzbergen, described previously.

It thus brings into warmer latitudes all the ice which remains from the melting influences of the Arctic summer, and also is continually floating southwards that which collects in Baffin's Bay and its inlets. Its southward drift is constant, winter and summer, as has been demonstrated by the drift of several vessels of the Arctic searching squadrons—as the Grinnell Expedition, Sir James Ross, H.M.S. *Resolute*, Sir L. M'Clintock in the *Fox*, &c.

About 10 miles per day may be taken as the drift down Baffin's Bay, as estimated by the author in the "Journal of the Royal Geographical Society," quoted previously.

(314.) The Baffin's Bay Current and the Spitzbergen Current has joined in the strength, set with great force down the coast of Labrador, the westward tendency being probably owing to the earth's rotation, which here rapidly increases southwardly in these parallels. It is probable that it sets at from 1½ to 2 miles per hour, close ashore on the Labrador coasts. But its chief interest to the sailor are the masses of drift ice and tremendous ice-

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has been so frequently met with around Cape Farewell and off the West coast of Greenland. A few examples will suffice. A plank of *mahogany* was drifted to Disco, and formed into a table for the Danish governor at Holsteinborg ("Quarterly Review," No. xxxvi). (But Admiral Sir Edward Belcher thinks that this plank is not mahogany, but is black-birch, and therefore is a Siberian produce. If it had made such a lengthened voyage as that from the Gulf of Mexico, it would have become worm-eaten.) Admiral Löwenörn picked up a worm-eaten mahogany log off the S.E. coast of Greenland. Captain Sir Edward Parry, in his second voyage, September 24th, 1823, picked up a piece of yellow pine quite sound, in lat. 60° 30′ long. 61° 30 W.; and on his third voyage seven pieces of drift-wood were found in the vicinity of Cape Farewell. Again, Captain Sir John Ross found much driftwood around Cape Farewell; und Captain Sir George Back saw in lat. 56° 50′, long. 36° 30′, a tree with the roots and bark on. These instances might be multiplied; but, as has been before stated, it is very probable that the drift-wood has come from the northern coast of Asia.—Ed.

bergs which it floats southward across his track, and constitutes one of the most formidable dangers of the Transatlantic navigation. As this is the most important feature it has, it will be dilated on more fully hereafter, as the limits within which these ice-drifts are encountered are also the limits of the current now being discussed.

(315.) These *ice-drifts* are seldom met with to the eastward of the meridian of 49°, that is, about 300 miles beyond the limits of the Grand Bank. Near to the banks they become more numerous, and in some years the sea appears to be covered with them, and vast numbers of bergs ground on the banks.

To the southward the extent of this ice-drift is uncertain, as it depends upon two causes: the one, the force and extent of the Arctic current from the northward; and the other, the depth to which the icebergs are immersed. As before-mentioned, there appears to be a perpetual struggle between the opposing forces of the Arctic Current and Gulf Stream to the southward of the banks. This process, invisible at other seasons, is made apparent during the season of the ice-drifts by the deeply immersed bergs passing quite into the course of the Gulf Stream under the influence of which they rapidly disappear. As will be seen presently, the view now accepted of this phenomena is that the Gulf Stream overruns the cool waters proceeding southward and south-westward; and although the northern edge of the warm waters of the stream are met with in the summer months over the southern end of the Newfoundland Banks, or as high as 45° N., yet these bergs are found drifting as far South as 39°, and even to 36° 10′, or 420 miles southward of the banks, and beyond the limits of the Gulf Stream.

(316.) The waters of the Arctic Ocean are thus brought again into that system of circulation which gives to sea water a universal character (168). In former years it was not thought that its effects extended further than this, and the cool S.W. current inside the Gulf Stream was considered to be an eddy of that great current, whose temperature was dependent on the shallowness of the soundings, in contradistinction to the supposed unfathomable depths of the Gulf Stream. Captain *Pornton*, in the earlier editions of this work, had, however, been led to conclude that the southward drift past Newfoundland, and the current from the Gulf of St. Lawrence with the eddy from the Gulf Stream, combined to form the counter current in question.

Its true character was first argued out by Mr. *W. C. Redfield*, a name well known to science. He drew up a summary of remarks and suggestions for the observers of the United States' Exploring Expedition, under Captain Wilkes, in 1838, and which was read before the American Philosophical Society in May, 1843. From that paper we will make a few extracts:

" . . . . From what source is that south-westerly current derived, which commonly prevails along the coast of the United States, in the direction which is opposite to the Gulf Stream?

"I am aware that it is usually considered by seamen as an eddy current derived from the Gulf Stream; but from this view I am compelled to dissent. For, in the first place, this current never assumes the gyrating form of an

eddy; but continues its course, when unobstructed by gales, in a direction which is generally parallel to the coast. But, secondly, in case this current be derived from the Gulf Stream, it must necessarily partake of the same elevated temperature; whereas the reduction of temperature which occurs on crossing the north-western limit of the Gulf Stream is most remarkable, and is almost without parallel in the Atlantic, except in the immediate vicinity of ice.

"It appears vain to allege the proximity of soundings or shallows as explaining this extraordinary change of temperature, for this cannot avail if the waters of the counter-current be derived from the Gulf Stream, to say nothing of the erroneous character of the position here noticed.

"From the evidence which is afforded by numerous facts and observations, it appears that the current in question is neither more or less than a mere sluggish prolongation of the *Polar or Labrador Current*, which sweeps along the north-eastern shore of this continent and the Island of Newfoundland; and this current, if I mistake not, may be traced in its gradations of temperature, by the thermometer, from off the southern coasts of Newfoundland and Nova Scotia, through the entire distance, to Cape Hatteras, if not to Florida.

"An eddy current, off-setting to the Gulf Stream, would nowhere be so likely to be met with as at the point of intersection of this stream with the extremity of the Grand Bank of Newfoundland, and sweeping from thence upon the southern shores of the island of that name; and yet the harbour of St. John's, in the southern part of Newfoundland, is known to have continued ice-bound, in 1831, so late as the month of June, although in the latitude of Paris. This fact is a convincing proof of the unimpeded continuation of the Polar Current to the southward, in this region, notwithstanding the near proximity of the Gulf Stream."

H.M.S. *Challenger*, proved the correctness of this theory. In May, 1873 (210 miles S.S.E. from Sandy Hook), proceeding to the northward, Sir Wyville Thomson says,* "Although on the surface the influence of the Gulf Stream was still felt to a certain extent, the contrast between the observations of this day and the day before was most marked. We had crossed the 'cold wall,' and the temperatures registered were almost purely those of the Labrador return current. . . . The collection as a whole had a decidedly Arctic character and recalled some of our dredgings on the coast of northern Europe, although it seemed that few of the forms were absolutely identical." The temperature soundings (p. 412) will give an idea of the way in which the cold water underlies the warm in this region.

(.317) The velocity of the current over the Banks and to the southward of Newfoundland is very variable, but at times is great. We can rather argue from its effects than from direct observation; for one result of this influx of warm water into a cold region is the production of dense fogs so peculiarly characteristic of the Banks. "Bank weather" is not favourable to astronomic observations, and hence the paucity of them.

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* "Voyage of the *Challenger*," vol. i., p. 375.

(318.) Upon a survey of the *Virgin Rocks* in July, 1829, the current at about 80 miles E. by S. from Cape Race was found setting over them to the W.S.W. at the rate of a mile an hour.

To different currents must be attributed the loss of the sloop *Comus*, the transport *Harpooner*, H.M.S. *Drake*, and the brig *Spence*, all of which were lost, at different times, upon *one spot;* the little bay, called *St. Shot's Bay*, on the South coast of Newfoundland, and lying between Cape Freels and St. Mary's Bay. The particulars of all these melancholy events have been given in our "British American Navigator," pp. 5, 6, and therefore need not be repeated. The *Comus* was from the West, and was lost in the night of the 24th of October, 1816, after having sounded, as supposed, on the inner edge of the Green Bank. The *Harpooner*, a transport with troops, was from Quebec, and bound for London. She struck at 9 p.m. of November 10th, 1816. The *Drake* sailed from Halifax for St. John's, 20th June, 1822, under very favourable circumstances, upon a direct course for Cape Race; but on the 23rd the weather became thick, and at noon she was supposed to be 90 miles from Cape Race, but at half-past seven p.m. breakers were reported ahead, and the ship was soon after a total wreck. The *Spence* was from Richibucto, in the Gulf of St. Lawrence, with lumber, bound to Liverpool, and was totally lost at St. Shot's, at four p.m., 16th July, 1822. Another vessel, the *George Canning*, from Chaleur Bay to Aberdeen, was wrecked here, during a dense fog, on the 17th of June, 1829.

The five vessels, it may be seen, were all from the *westward*, and all, it may be presumed, were set to the *northward* as well as to the *westward*, of the situations which they were supposed to occupy, and the route which each intended to pursue. They can be accounted for only by the supposition of currents winding round the coast, opposing each other, and operating as above explained; for it seems clear that the westerly current from the Grand Bank so opposes the easterly one as to limit its operation *eastward*, and give it a northern inflection; thus producing the indraught into the southern bays of the island.

It appears that the south-westerly current, over the Grand Bank, sets over the whole of the northern part of that bank. In a summer voyage, 1826, lat. 46° 24′, Lieutenant Hare (30th September) sounded on the outer edge of the bank, with thick blowing weather from S.W.; and, on the next day, in 45° 56′ N., and 48° 6′ W., had no bottom at 120 fathoms, with a very heavy swell from W.S.W., although he found that a current had carried him S. 67° W. 34 miles. Thus appeared, in close conjunction, a south-westerly current, with another from W.S.W., where the edge of the two entered into collision with each other.

(319.) The current which sets out of the Gulf of St. Lawrence, between Newfoundland and Breton Island, also adds its effect to the current setting to the S.W. It is composed of the stream of fresh water which constantly sets down the river, and the water which enters from the Labrador current through the Strait of Belleisle.

The current usually sets into the Strait of Belleisle, between the island and the coast of Labrador. It transports immense quantities of ice in some years into the Gulf, if they are not too large to be intercepted by the moderate depth of the strait, although this feature varies very much indeed in

different years. This current has been observed to run 2 miles an hour with the wind from N.E., while at other times it is almost insensible, and it is stated sometimes to run in the opposite direction, especially during the ebb tides with S.W. winds. After it enters the gulf, it runs 39 or 50 miles further, when it becomes dispersed and merged into the general streams.

The outset from the gulf is very frequently of some considerable strength, especially with westerly winds or in calm weather. But its strength is reduced, or it even is retarded altogether, with opposing winds, which have a powerful effect on it at all times.

Both these currents are modified by the tides, but in a way directly contrary; for, while the Strait of Belleisle current is ameliorated by the flood, and retarded by the ebb, the other is increased by the ebb and checked by the flood tide which enters the gulf from the southward. The tidal hour is therefore important in estimating the probable set of these currents, which, however, it may be said to be exceedingly difficult at all times to estimate and allow for correctly.

(320.) *Sable Island* has been famous for its wrecks, which greater knowledge and consequent caution have rendered less frequent. Its position and formation are remarkable, as it lies apparently in the strength of the Arctic Current. Its dangerous character is greatly increased by the prevalent fogs which are dense and very constant. As is well known, it is a mere sand-bank, with two parallel ridges of sand blown above the sea level, and forming a curve convex to the southward, showing the direction of its principal growth. From each end extend long "bars" or shoals; that to the West extends 17 miles, and that to the East 14 miles, the whole extending over 50 miles. The westerly winds and current tending in the same direction are constantly wearing away the West end, and adding to the East, by drifting the sand of which it is formed and that which it brings to leeward.

The wrecks, which now average two annually, have usually occurred from the effects of the S.W. current which we are now considering, and which, though irregular in its action, has usually some effect on a ship's course; added to this, as has been previously shown, the Gulf Stream is here found with much diminished force, and consequently there are some anomalies in the immediate neighbourhood of Sable Island. The best account we have of the streams is that given by Mr. Darby, who was superintendent of the establishment here.

Mr. Darby has said, "On the South side of Sable Island, the current, in shoal water, with prevailing South and S.W. winds, sets rapidly eastward until it reaches the end of the N.E. bar. It then unites and blends with the *St. Lawrence Stream*, which passes the bar in a S.S.W. direction, and runs strongest in April, May, and June. I have sufficient reason for believing that the Gulf Stream, on the parallel of 42° 30′, running E.N.E., occasions the St. Lawrence Stream, then running S.S.W., to glide to westward. The strength of this stream has never been noticed, and three-fourths of the vessels lost on Sable Island have been supposed to have been to the *eastward* of the island, when, in fact, they were in the longitude of it."

"Easterly, southerly, and S.S.W. winds set a rapid current along shore in shoal water, to W.N.W. and N.W.; that is, along the shore of the western end of the island, but not the eastern nor middle, as there the cur-

rent, with southerly and S.W. winds, sets to the eastward. The natural tendency of the flood-tide is toward the coast. When it strikes the island it flows to the eastward, over the N.E. Bank, and to the westward, over the N.W. Bank, and passes the West end in a N.W. direction, so rapidly that it carries the sand with it; and the hills of the West end being high and narrow, they are undermined at their base by it, and tumble down some thousands of tons of sand at a time. This the current beneath catches, and sweeps away to the N.W., increasing the bank. So soon as the current passes the extreme point of the dry bar, it tends more across the bank to the N.E.; the motion of the sea contributing to keep the sand in motion; the current carries it to the N.E., and spreads to the N.W.."

(321.) In following the course of this current along the coast of the United States, we have no very clear notion of its mean velocity; but that it does run to the southward, we have many evidences, besides the temperature of its waters. It is probable that the surface, at least, is obedient to the varying of the winds, which blow over it, but it preserves its course almost unimpaired and quite appreciable on the surface as far South as Cape Hatteras, after which its presence does not appear so manifest, except as a submarine current. In (272), (286), &c., the presence of the cool water it transports is shown to exist, in a great degree, even close beneath the warmest and strongest parts of the Gulf Stream.

There is great evidence of current action all along the coast of the United States beyond the Cape Cod Peninsula, itself of remarkable formation. The long straight lines of low alluvial shores, fronting extensive shallow lakes, separated from the ocean by narrow beaches thrown up by the sea, all bespeak the work of the ocean and its drifting waters.

There is another singular feature, too, in the more southern portions of its course. The long lines of shoals which project seaward from the Capes Hatteras, Fear, Look-out, &c., that is, in the section where its surface action is not so manifest, indicate some process going on which as yet has not been entirely explained.

In a nautical sense the allusion to this current is sufficient to guard against its effects in approaching the coast, or in taking advantage of it to work against the current of the Gulf Stream. No particular instructions have been issued respecting it, and, therefore, this will close our notice of it as an inner current of the Gulf Stream.

(322.) There is another part of the ocean in connection with this where the currents are not strong or regular, but peculiar. It is the part between Bermudas and the coast of Georgia. There seems to be some connection with the fact of Cape Hatteras cutting off a portion off its southern progress and the very irregular temperatures that are met with to the south-eastward of that cape. The cold veins alluded to on page 401 (285) are, perhaps, a portion of this; but it certainly seems as if the cold water, after passing under the Gulf Stream, appears on the surface intermingled with the warmer waters of the Equatorial Current, and cause a slight drift to the south-eastward, and have something to do with that eastward tendency of the Gulf Stream (292) in throwing off its floating objects to the eastward of its course—a fact which has been attributed to its being "*roof-shaped*," a

form owing to the greater force and velocity of its centre, which causes the water along the middle of its course to be higher than the lateral portions.

In the southern part of this current its influence on navigation, as said above, is of minor consequence. Its principal feature is its ice-transporting powers in the more northern portion of its career; and as this has a most important bearing on the navigation between Europe and America, some notice on this point follows.

ICEBERGS, ICE ISLANDS, AND DRIFT ICE IN THE ARCTIC CURRENT.

(323.) Although we have noticed the annual floats of ice which descend from the northern regions, it may not be inapposite to recall to the seaman's mind the necessity of guarding against these tremendous and dangerous objects—more dangerous than permanent rocks, because unfixed, and more dreadful, because frequently obscured in snow and fog.

The ice which is thus met with is of two descriptions; that which is formed on the surface of the sea during the polar winter—the field and floe-ice; and that which is formed in the course probably of many years upon land, and is periodically launched into the sea in the form of gigantic bergs of enormous height and dimensions.

Of the first description of ice no special mention is necessary, as its production and presence in the regions under consideration is very readily comprehended.

(324.) *Icebergs* are a much more interesting subject, and their majestic proportions at once attract attention and invite enquiry as to their formation; consequently we find many accounts and speculations have been advanced to account for them, and various localities pointed out as their birth-place.

Captain (afterwards Dr.) Scoresby, whose opinion is invaluable, observes, "that, however dependent the ice may have been on land, from the time of its first appearance to its gaining an ascendancy over the waves of the ocean, sufficient to resist their utmost ravages, and to arrest the progress of maritime discovery at a distance of, perhaps, from 600 to 1,000 miles from the Pole, it is now evident that the proximity of land is not essential, either for its existence, its formation, or its increase."

Dr. Scoresby's acquaintance with ice-bergs in progress of formation was confined to Spitzbergen and portions of Greenland, where they do not form so marked a feature as has been found by others. It is to Dr. Rink, a resident in Greenland, that we are indebted for the most complete account of these marvellous phenomena, and in making a few extracts from his work,* we may draw attention to the parallel condition of the South Pole in

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* Dr. Rink "On the Origin of Icebergs," &c., Journal Royal Geographical Society, vol. xxiii., 1853, p. 143, *et seq.*

producing these icebergs on a far more stupendous scale than is found in the northern region; for while in the North their dimensions are confined to a few hundred yards, in the South they are very frequently miles in extent, and from 2,000 to 3,000 feet in thickness—a magnitude owing to the vast extent of country in which they are produced as explained on p. 434 (327). Their protrusion into the sea involves the same considerations as the "glacier theory" of the land, so very interesting and important in geological questions.

(325.) The larger icebergs in the northern regions rise above the surface of the sea to the height of from 100 to 150 ft. and upwards, and some are 4,000 ft. in circumference. The part *above* can scarcely be considered more than one-eighth of that *below* the surface of the water, so that the cubic contents of the iceberg may amount to 100,000,000 of cubic ells, or about 66,000,000 cubic yards—a fragment of ice which, if we suppose it to be fairly landed, would form a mountain about 1,000 ft. in height. All agree that the icebergs of these arctic seas are originally formed on *terra firma*, from the snow and rains which, from the severity of the climate, are never able to reach the ocean in a fluid state, but which, in the course of years, are transformed into a mass of ice, and are then, through some physical agency, thrust forward into the sea.*

The ice thrust forth into the sea, in the form of massy mountains, is originally formed over an enormous extent of country, from whence it, by an agency similar to that by which the progress of glaciers is effected, is thrust forward and brought to a point at the place from which the icebergs proceed. For the formation of icebergs accordingly a tract of land of a certain extent is necessary, in which the sea forms so few and small creeks or inlets that rivers or watercourses of some magnitude must necessarily be present.

(326.) Where the above-mentioned condition exists, in conjunction with the necessary temperature of the climate, the formation of ice does not proceed from certain mountain heights, but *the whole country is covered with ice to a certain elevation; mountains and valleys are levelled to a uniform plane; the river beds are concealed, as well as every vestige of the original form of the country.* A movement, commencing *far inland*, thrusts the outer edge of this mass of ice forward toward the sea; and when it reaches the frith it may be seen to sink, and to diverge and even extend out several miles. There the agency of the *obliterated rivers* may be observed in the greater or lesser

* It is a well known fact that all the ice formed from snow upon the surface of land, where the heat of summer is incapable of melting and preventing its gradual increase, has a tendency to extend and move downward, as water should do, according to the same laws, in the case of rain instead of snow having fallen upon the surface. Those masses of snow accumulated in high regions of mountain chains, even in the hottest parts of the globe, gather in the valleys, which thus form the natural drainage for the highlands, and being congealed into a compact body of ice, move slowly down into lower and warmer regions, till the increasing heat, by thawing them, sets a limit to their further spread. These masses of compact ice spreading down through the valleys or clefts, and constantly furnished with further supplies by the snow accumulated in the surrounding highlands, are, in Europe, seen on the largest scale upon the Alps, where they are known under the name of "Gletcher," or glaciers.

rapidity with which the matter in a solid state is carried forward to the ocean. The massy crust, *still preserving its continuity*, proceeds from the shore, borne by the sea, until some circumstance or other destroys the equilibrium, and breaks some fragments off the outer edge, which is again thrust forward, and again detaches new fragments, thus continually renewing the supplies from the interior.

(327.) A track or body of land of the requisite size is, in the northern hemisphere, only to be found in Greenland, and more especially in that part which lies in the North of Arctic Circle, where in the interior, beyond the inlets of the sea, the country increases in breadth from East to West, and affords space for the original birth-place of these large ice-bergs. Neither Spitzbergen, nor the narrower parts of Greenland, nor the Peninsula, nor the islands which surround it, are adequate in size to produce the yearly excess of indissoluble ice, which, *from that large and unknown continent, is very slowly protruded;* and, as it seems, in a lesser degree toward the eastern shores of Greenland, along with the icebergs are driven past Cape Farewell, the greatest quantity going to the West, into Baffin's Bay. The friths or fiords, which, piercing far into the country, receive and transmit the icebergs, are called *ice friths.*

(328.) From November to June the water, in which the icebergs are to proceed to the ocean, is so covered by the ocean ice, that they are shut up in the inner ice friths; but in July, and especially in August, they are carried in mass by the current to the open sea. This is called *the shooting out of the ice friths*, which lasts till late in the autumn, when the continually easterly storms finally clear out the inner waters, unless the icebergs are intercepted by certain banks, on which they sometimes remain long aground.

(329.) Icebergs consist mostly of hard, brittle ice, of which the white colour originates from very fine lineal pores, uniformly divided through the whole mass, all being of the same size, equi-distant, and parallel throughout the whole iceberg. This uniform structure may have arisen at the time it was formed in the interior of the country from corned snow—perhaps repeatedly thawed and frozen. The white iceberg is in many directions crossed by broad stripes of intense blue coloured ice, which is quite clear, and either contains no air bladders, or, at all events, very irregular ones. These blue stripes are several ft. in dimension, and in them are generally found "dirt bands" of foreign matters, such as stone, gravel, and clay, which the icebergs carry off embodied in them. The *blue* ice is, by thawing, dissolved into regular large grains, which is not the case with the *white* ice that forms the main mass of the icebergs. It seems probable that these blue strips are formed by a filling up of the fissures in the *inland* ice with water—perhaps mixed with snow, gravel, and stones; and such a refrigeration of the water in the fissures may be supposed to be an important agency in setting in motion these great mountains of ice.*

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*Transparent ice, free from interior spaces or bubbles, is one of the purest substances in nature, and it is not possible to detect the presence of the minutest portion of air, or any substance that may have been held in solution by the water from which it is formed. The strongest poisons, or colouring matter of any description, are most effectually separated from water by the process of freezing it. This must, of course, only be understood to

It would be out of place to enter into detail upon this subject, but from the above-mentioned notice, as well as the works of Dr. Scoresby, Sir George Nares and others much interesting matter may be gleaned. We must, therefore, consider them here as only affecting navigation.

(330.) *Mr. W. C. Redfield*, to whom the world is so largely indebted for his researches in meteorology and physical geography, published a pamphlet, accompanied by a chart, upon the ices of the North Atlantic. In this he has clearly shown that the Gulf Stream *passes over* the cold Arctic Current, which transports the deeply immersed icebergs into and across it. "No impulsion but that of a vast current, setting in a south-westerly direction, and passing beneath the Gulf Stream, could have carried these immense bodies to their observed positions, on routes which cross the Gulf Current, in a region where its average breadth has been found to be about 250 miles. Other observations on this subject have been given in the chapter on the Gulf Stream. The same influence will also cause the presence of floating ice in the Gulf of St. Lawrence, by carrying it through the Straits of Belle Isle; but the depth of this would prevent the progress of the larger icebergs (319).

It need scarcely be mentioned, that greater circumspection is necessary in passing near the regions where these dangers may reasonably be expected. The following instances selected from many others, may operate as sufficient cautions:—

(.331) On the 21st of June, 1794, in lat. 45° 18′, on the eastern steep edge of the Grand Bank, in a thick fog, H.M. frigates *Dædalus* and *Ceres* were suddenly involved amidst some very high and dangerous islands of ice. The weather was so thick that objects were not visible at 50 yards distant. The *Dædalus* commanded by Sir C. H. Knowles, hauled up and passed close to the stern of a ship that lay stranded upon one of the ice islands, and sailed to windward of it through a great quantity of drift ice, and to leeward of another ice island. The *Ceres*, Capt. Thos. Hamilton, passed in the same track, and saw the wreck a quarter of an hour after the *Dædalus*. The course was East, the wind S.W., the sea very high, as the wind blew hard the night preceding, from the southward.

Again on the 15th of June, 1810, the *Dædalus*, commanded by Captain Inglefield, with a fleet from Jamaica, in lat. 41° 33′, and long. 51° 17, to the southward of the Grand Bank, passed two icebergs, and the next day another; providentially the fog, which had been very dense, cleared up for an hour, and allowed the fleet to clear the dangers.

On the 2nd of August, 1813, H.M.S. *Bedford*, 74, then bearing the flag of Vice-Admiral Stirling, accompanied by the *Cyane*, Captain Forrest, and *Fawn*, Captain Fellowes, with a fleet of 105 sail from Jamaica, at eight a.m., just as the fog cleared away, fell in with an extensive ridge of ice, having an iceberg at each extremity, and about 1 mile in extent, even with the water, over which the seas broke with considerable violence. Had the fog not cleared up as it did, about thirty ships must have struck upon it, as that number were steering directly for this formidable reef, and were within the extent of its sweep. The thermometer was at this time ranging from 63° to 65°, in lat. 45°, the long. 44° 30′.

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refer to those masses which are quite clear and transparent, or the spaces or vacancies left in the ice will naturally contain portions of the adventitious matter. Ice, therefore, is one of the best sources from which a supply of fresh and wholesome water can be obtained, and if these hollows be washed in fresh water, ice water will be found preferable to, and purer than any other.

On the 31st of August, 1816, Captain Gooday, in the ship *Jones*, on his passage from St. Petersburg to New York, in lat. 46° 50′, long 47° 53′, saw an island of ice, from about 1 mile to 1½ mile long, and from 54 to 70 ft. high. When first seen, it appeared like a white cloud.

In January, 1818, the brig *Anne*, of Poole, W. Dayment, master, left the harbour of Greenspond, Newfoundland, in the morning, and in the evening of the same day got among ice; proceeded thus about 40 miles, and at daylight next morning was completely beset, and no opening to be seen in any direction from the mast-head. In this state the vessel continued for fifteen days, drifting with the ice about 60 miles S.E. by E., or about 4 miles in every twenty-four hours. The ice was now become very heavy, high above the surface, and about twenty-nine large bergs were in sight. With this ice the vessel drove until she was in 44° 37′ N., and about 300 miles to the south-eastward of Cape Race, when, on the 17th of February, she got clear through the only opening that appeared in the horizon from East to S.E., all the rest of the circle forming one compact body of ice, as far as the eye could reach. The vessel had been shut in for twenty-nine days, in the last fourteen of which she drifted from lat. 46° 57′ to lat. 44° 37′, about 280 miles, or 20 miles a day, S.E. by E. tremendous gales of wind blowing the whole time from the West to the N.W. In the course of this passage the master declared that he saw more than 100 large islands of the solid blue ice, known to traders by the name of *Greenland Ice.*

On the 17th day of the same month, January, 1818, the brig *Funchal*, of Greenock, sailed from St. John's, Newfoundland. At about 15 miles to the westward of this port she fell in with a field of ice coming down from the northward, about 8 miles in breadth, and extending to the northward beyond the reach of sight. Having cleared this, and proceeded westerly about 250 miles, on the 20th, in lat. 47½°, she encountered a still more extensive field, floating to the westward, in the midst of which was an iceberg; she cleared this, though not without difficulty, and brought with her a gale of wind, with snow, sleet, and rain, the whole way to Scotland.

On the 6th of May, 1823, the *Mountstone*, of and from Plymouth, was lost on an iceberg, on her passage to Newfoundland. The master and crew, with passengers, in all ten persons, took to the boat, without provisions, from which three only of the number were taken by a passing ship, on the 14th of the same month, the remainder having died of hunger!

Our next case is that of the *Ajax*, of Wiscasset, New England, on the passage toward London, March and April, 1826. The following is an extract of a letter from William S. Shaw, the commander, to his owners on the subject. His means of protecting the vessel, under perilous circumstances, are worthy of especial notice.

"On the 12th of March, at 4 a.m. (sea account), between lat. 42° and 44° North, weather thick and cloudy, with squalls of hail and snow, we ran the brig in between two reefs of ice, jammed together apparently in a solid mass, the sea being much smoother than usual, which did not alarm us; we knew we were far from land or breakers, until we felt the ice alongside of us; so soon as we perceived which, we hove-to until daylight, when we found we were surrounded by a solid body of ice. Around us were thirty icebergs, about 150 ft. high, and nearly the size of Segwine Island. Finding the ice chafed us badly, we got out fenders. As we had run into the ice before the wind, it was impossible to get out the same way. At sunrise discovered a narrow opening to leeward, for which we steered under easy sail, and drove her through. We were now in a bay, about 1½ mile wide, the reefs on either side, and large cakes of ice in contact with us.

"The wind still blowing fresh at N.W., we kept her before it about 3 miles, but could not discover an opening to the southward and westward; tacked and steered N. E. about 12 miles, it being very difficult to avoid the large cakes of ice that crowded thickly around us.

"Finding there was no opening in this direction, and that the two reefs extended as far as we could see—that there were numerous large islands of ice North of us, and an almost innumerable collection of small ones ahead, we concluded at 10 a.m., to crowd her through the ice; and having prepared fenders of every kind, such as old junk, spars, cordwood, bales of cotton, and part of one cable, we drifted her into it. We were now in the midst of the ice in a severe gale, accompanied with a thick snow storm; and had it not been for our precaution, in preparing fenders, the ice must have soon made a hole through us. At mid-day, old Sol deigned to show his brazen face, and laughed at our comical situation. This circumstance enabled us to take an observation, by which we found ourselves in lat. 44° 30′ N., and long. 43° W. (between the Azores and Newfoundland).

"As our fenders were nearly destroyed, we were compelled to cut up more of our cable, wooden fenders not sinking deep enough for the purpose of defence under water. You may judge of the difficulty of *crowding* the brig through by our progress which was but half a mile an hour, under two reefed topsails and foresail, the wind blowing heavily. At one o'clock p.m. we suspended two bales of cotton under our chains, that they might not be carried away by rolling against the cakes of ice which we occasionally met, some of which were 100 feet in circumference, and 6 feet thick.

"At one time we were so completely enclosed, that I got out, with part of the crew, and walked on the ice—a walk that few mariners have probably enjoyed at that distance from land on the Western Atlantic Ocean. At 8h in the evening, found the surrounding ice much thinner, and the islands less frequent; handed all sails except the close-reefed main-topsail, which we hove to the mast to keep her from ranging ahead on the islands.

"At daylight, finding ourselves clear from the great body of ice, though not from the islands, we made sail, and steered E.S.E. and E.N.E. for three days, with a good breeze, and under short sail during the night. It was the opinion of all hands, that we sailed *three hundred miles* before we were clear of the large islands of ice."

In July and August of the same year, 1826, H.M.S. *Ringdove* was on her passage from New York, and fell in with an immense iceberg off the Banks of Newfoundland, drifting to the southward, the magnitude and sudden appearance of which astonished every person on board. For the description of an iceberg seen by Capt. J. S. Park, 29th June, 1826, see page 440.

In the month of March, 1828, several vessels arrived at New York, which had fallen in with islands of ice in lat. 43° to 44°, long. 47° to 49°. This was considered as unusually early in the season for such dangers to be met with. In this season the brig *Catherine and Hannah*, Captain Lumsden, which afterwards arrived at Cork, picked up, on the 4th of May, in lat. 45° 11′, long. 56° (near Banque-reau), a boat belonging to the *Superb*, of and from Bristol, for Quebec, which ran foul of an iceberg on the 21st of April, that stove her forward. This unfortunate occurrence obliged all hands to take to the pumps, at which they continued without intermission for two days and a night, when a schooner hove in sight; and the captain proceeded in the jolly boat to treat with them to take the crew. While the captain was so engaged, the vessel being quite in a sinking state, the crew left the pumps to get the boats out to leave her. They succeeded in getting out a boat (the one subsequently picked up), and seven men got into her; upon which they unhooked the tackle, slipped from the ship, but could not regain her, and it coming on thick weather, they could not find the schooner; thus the unfortunate men were left without provisions, water, mast, sail, or anything that would enable them to struggle for existence, save and except two oars. In this state they were buffeted about for eleven days, when

they were fallen in with by the *Catharine and Hannah*. Of the seven men only two were alive; and one of these survived only twenty-four hours. It is almost superfluous to say, that the only food which they had taken was the bodies of their deceased companions.

Captain Barclay, of the *Brilliant*, for Leith, from Quebec, which he left on the 5th of June, 1829, narrowly escaped shipwreck, having fallen in with a heavy body of ice, about 20 miles East of the entrance to the Strait of Belle-Isle in foggy weather. The vessel got clear on the 19th of June, after being three days and nights amongst them, and being obliged to proceed 1½ degrees to southward.

On the 11th of May, 1833, between the Outer and Grand Banks of Newfoundland, the brig *Lady of the Lake*, John Grant, master, from Belfast, with 230 passengers, in lat. 46° 50′, long. 47° 10′, fell in with ice, and while end avouring to pass between two large pieces, a tongue under water in the ice struck the port bow, and stove it entirely in. It is not requisite here to repeat an afflicting detail; the consequence was, that the brig soon foundered, and only the captain, with fourteen other persons, were ultimately saved.

The barque *Perthshire*, R. Simpson, from Pictou, Nova Scotia, fell in with a field of ice, in lat. 46° 19′, long. 46° 40′, on the 8th of June, 1845. It was about thirty miles in extent, and on its North end there was a ship, high and dry on the ice, with the crew on board; but could not render them assistance.

(332.) The following are from Mr. Redfield:—"On the 1st day of January, 1844, Captain Burroughs, in the ship *Sully*, met with an iceberg in the Atlantic, in lat. 45°, long. 48°. This is earlier in the winter than any other case which we have met with. Captain B. states, that he had met with ice near this position on the 1st of February, on a summer voyage.

In September, 1822, Captain Couthouy saw an iceberg aground on the eastern edge of the Grand Bank, in lat. 43° 18′, long. 48° 30′. Sounding 3 miles inside of it, the depth was found to be 105 fathoms. In the month of August, 1827, the same observer while crossing the banks, in lat. 46° 30′, long. 48° W., passed within less than a mile of a large iceberg, which was stranded in between 80 and 90 fathoms. He was so near as to perceive distinctly large fragments of rocks, and quantities of earthy matter embedded in the sides of the iceberg; and to see from the fore-yard, that the water, for at least a mile round it, was full of mud, stirred up from the bottom by the violent rolling and crushing of the mass.

On the 27th of April, 1829, Captain Couthouy passed, in lat. 36° 10′ N., long. 39° West (probably South of the Gulf Stream), an iceberg, estimated to be a quarter of a mile long, and from 80 to 100ft. high. It was much wasted in its upper portion, which was worn and broken into the most fanciful shapes. In 1831, at daylight of the 17th of August, lat 36° 20′ N., long 67° 45′ W., upon the *southern* edge of the Gulf Stream, he fell in with several small icebergs, in such proximity to each other, as to leave little doubt of their being fragments of a large one, which weakened by the high temperature of the surrounding water, had fallen asunder during the strong gale which had prevailed from the S.E.—*Silliman's Journal*, vol. xliii., 1842.)

Ship *St. James*, Meyer, July 12th, 1844, lat. 44°, long. 47° 12′, passed twelve large icebergs; July 20th, passed 25 ditto; and July 21st, passed 30 ditto, lat. 43° 50′ long. 52° 26′, saw the last of it.

Ship *Formosa*, Crawford, June 18th, 1842, lat. 38° 40′, long. 47° 20′, saw an iceberg 100 ft. high, and 170 ft. long.

(333.) A very interesting item in our enumeration of ice-floes is that of those met with in April, 1851, on which were the wrecks of two ships, which had the appearance of, and from all probabilities were, the ships of the unfortunate Arctic expedition under Sir John Franklin. The particulars have been so extensively detailed

elsewhere, that we shall merely give the original announcement, which will suffice for the present purpose. Much more extended particulars will be found in the public newspapers of April the 9th, 1852, and subsequently; the "Nautical Magazine," May, 1852, page 265, *et seq.*; and the "Parliamentary Paper," on the Arctic expedition.

The brig *Renovation*, of Shields, Captain E. Coward, bound to Quebec, on April 20th, 1851, when near the East edge of the bank, in lat. 45° 30′, wind N.E., fresh breeze, clear weather, as much as they could carry fore-topmast studding-sail, fell in with ice-floes, one of which was very large, with field-ice attached, on which there were two three-masted ships, having their masts struck and yards down, and all made snug; to all appearance they had all passed the winter together on the ice. Took the spying glass, and carefully examined them to see if there was any one on board, but could see no one, &c. &c. A further statement says they were apparently two full-rigged ships (one about 500 tons, and the other 350), on an iceberg, high and dry, the larger one on her beam ends, &c. Singularly enough this statement had been published in the "Limerick Chronicle," May 28th, 1851, a year previous to any notice having been taken elsewhere.

In our minds there is no doubt but that these were the ill-fated ships which had been drifted out of Melville Sound and Baffin's Bay; and thus eluded all the elaborate and anxious searches that were made. The incident is a singular one in the history of arctic ices.*

The *Carlo Mauran*, commanded by Mr. Tillinghors, passed on May 23, 24, 25, 1851, between lats. 44° and 45°, and long. 49°-54° large quantities of ice.

On June 27, 1851, the *Washington* steamer, from New York to Southampton, passed 10 very large icebergs between longs. 50°-45° in lat. 47°.

(334.) Lieutenant Evans, the intelligent officer to whom we are indebted for a part of these extracts, says, "There is scarcely a doubt but that most of the vessels from the West Indies and America, that have been missing, perished in the same manner as the *Mountstone*, icebergs having been met with some degrees to the southward of the Banks of Newfoundland in June and July. The commanders of vessels, therefore, who have occasion to pass between the parallels of 35° and 50° N., cannot be too cautious; a look-out man should be placed on the fore-yard during the night, and in foggy or hazy weather, also in the day time. In addition to these, there should be one on each bow; and during a fog the foresail should be hauled up, especially in crossing the banks, where the icebergs have been met with aground. Careful attention, too, should be paid to the thermometer, as experience has shown that to be an indicator of the vicinity of ice. Captain Franklin observes, that the approach to ice would be evidently pointed out in those parts of the Atlantic where the surface is not continually chilled by the passing and melting of ice, as in the Arctic Sea; and he strongly recommends a *strict hourly* attention to the *thermometrical state* of the water at the surface, in all parts where ships are exposed to the dangerous concussion

* See Journal of the Royal Geographical Society, vol. xxvi., pp. 26—35, "On the Probable Course pursued by Sir John Franklin's Expedition," by *A. G. Findlay*. Notwithstanding that this great mystery has been partially cleared up by the expeditions of Dr. Rae and Sir L. M'Clintock, yet no vestige of the ships themselves have been seen by Europeans. That portion, as well as others, is still involved in mystery; and the opinion is still tenable and maintained by many, that these derelict ships were the *Erebus* and *Terror*.

of floating icebergs, as a principal means of security. There would be very little trouble attending such a point of duty; yet, we believe, there are many masters who would not undergo it, but trust to chance the safety of their vessel, their own lives, and those of their crew and passengers. Many have made repeated voyages across the Atlantic without having seen floating ice, and therefore become incautious. It is to these we would particularly recommend the perusal of this paper. The following extract fully corroborates Captain Franklin's assertion:—"The morning of the 1st of August (says Captain Lyon) was thick and foggy, with rain; at 10 a.m. we discovered, through the haze, our first piece of ice, a small berg of about 70 feet; we soon passed this and several others, but saw no *floe* or *brash ice*, although there was every reason to suppose that a pack was near, from the sudden smoothness and change of temperature in the water, now at 32°, while the air was at only 31°. Repeated observations of this kind have now brought to a certainty the assertion, that the approach to ice from an open sea may be ascertained by the sudden change of the thermometer; and acting from past experience, I caused the more active look-out to be kept, on observing it to fall suddenly this morning; yet this change first took place in a very thick fog, and we ran about 10 miles before the ice was seen."

Cautions.—"Captain Weddell recommends that, with a free side wind, an iceberg or ice island should be passed on the windward side; and by this means, the loose ice, which always drifts furthest, is avoided.

We may sum up the admonitions which have been given by the following remarks:—

The indications of an iceberg are—1. A natural effulgence, or *ice blink*, which frequently renders them visible at some distance, even in the darkest night. At a short distance this effulgence may appear like a white cloud, extending over, or nearly over, the vessel's masts.

2. A considerable decrease in the temperature of the water, as shown by the thermometer, in comparison with the heat of the adjacent sea, and with the air above.

3. The roaring of the sea at the base of a berg, which may be heard by an attentive listener, when afar off.

(335.) Lieut. J. Steele Park, from whose journal we have given extracts elsewhere, recites the following incident, which will speak for itself an inculcatory *caution*:—

"*June* 29th, 1826.—A light breeze from the southward, with foggy '*Bank weather*,' as the sailors call it. Steering E. by S. At eight o'clock this morning it cleared away, and I took altitudes for my chronometer, which made the longitude 42° 42′; and, at the same time, we discovered an island on the starboard beam, 3 or 4 miles off. Shortened sail, hove the ship to, and sent the mate to see what it really was; for, although I had no doubt of its being an iceberg, yet it certainly looked something like land; and I did not wish to leave it in any kind of uncertainty. The fog, which had cleared away at eight o'clock, and left a beautiful blue sky, returned suddenly when the boat was about half-way from the ship. The mate, an active, skilful seaman, had a compass with him, and he apprehended no danger, but pushed on for the island, instead of returning, when he saw the

fog spreading. Hour after hour passed away, and no appearance of the boat. Night came on, dark as the grave, with a cold, benumbing drizzle, and a fog so dense that we could scarcely see across the deck. My grand object was to keep the ship as near the same spot as possible. All day and night we kept the bell tolling, and fired a great gun occasionally; a tar barrel was also blazing at the main-yard arm, but all was unavailing. I shall never forget the terrors of that night. I reproached myself as the cause of their destruction; and I prayed most earnestly for daylight and clear weather. I thought daylight would never come; but it came at last and the fog was thicker, if possible, than the day before. The most sanguine now began to despair. About five o'clock something was heard, like the blowing of a conch shell, but so faint and indistinct that we thought it was only the echo of the great noise we were making on board. However, it was soon discovered that the sound was coming nearer and nearer; but as no person on board knew that they had a shell in the boat, we were still in a sad state of anxiety; for it might, perhaps, be a ship sounding her shell in the fog, as is usual at sea. In a few minutes the splash of oars was heard, and in five minutes more the boat was alongside, with all hands safe and sound, thank God! but cold and hungry enough. The mate tells me he rowed round the iceberg, which he thinks was about 309 feet in length, 150 feet in breadth, and 40 or 50 feet above the surface of the water. It was melting away rapidly; streams of water were gushing down its sides, and they had only got a few yards from it, on their return, when (to use his own words) 'it took a sally and fell over on its beam ends.' Our last sight of the ice, when bearing S.W. 3 or 4 miles, was in lat. 42° 13′, long. 49° 44′."

IV.—MAGNETIC VARIATION.

(336.) Among the changes which have come over the system of navigation of late years, none have been more important than the different relation which the compass now bears to the ship as compared with its place in former times.

Rude instruments, unadjusted, with errors unsuspected, and under influences destructive to their accuracy, have given place to what may be, in some cases, over estimation, of this primary aid to the seaman. In its very nature the compass is imperfect and incompetent to show, at sea, the minute quantities, which are now disputed over. The consequence is, that it is made, like the topic we have just discussed, ocean currents, the scapegoat for many errors of seamanship and judgment, which a more intimate knowledge and therefore greater mistrust and induced caution would have avoided.

(337.) Our present task deals with the *geographic* distribution of magnetism, not with those local effects caused by the ship or its relation to outer circumstances, but to its position in the Atlantic. The other points, most important in themselves, must be discussed elsewhere.

The features of the earth's magnetism, as related to the ship, are the declination, inclination and intensity. The dip and intensity are very important elements in the adjustment of the compass in its passage through the varied magnetic conditions which an over-sea voyage across the Equator conducts a ship through, but they have but little influence on the directive power of the needle in the latitudes universally traversed in commercial pursuits. The *declination* or variation is one of the most important elements in navigation, and its correct estimation and application most essential to the safe conduct of a ship.

(338.) The reasons why the compass is now placed in so much higher consideration than it was in former years are manifest. The great increase of the use of iron both for ship building as well as in the fabric of wooden ships, and the consequent vastly increased influence that the ship has upon her compasses has been one chief reason why attention is so imperatively demanded. Again, since the universal use of steam, the course of a vessel in passing directly from one point to another requires to be much more accurately laid than was thought necessary when wooden ships only were used.

Another reason, which has arisen in the course of years, is that caused by the secular variation. The accurate government surveys, which have now been in progress for 40 or 50 years, in their earlier portions, in some cases, remained as they were issued, and consequently this change from the variation of the compass they show, has amounted to a considerable quantity, such as would endanger the safety of a vessel where they have been implicitly trusted to.

The appreciation of this change, which has thus become manifest simultaneously with the necessity for improved compasses and improved methods of using them, have placed the magnetic element in charts on a fresh basis.

NORTH
ATLANTIC OCEAN
Lines of Equal
MAGNETIC VARIATION
Lessons Jan.
1872
The Approximate annual change is shewn thus +0.5 in minutes and tenths + easterly & - westerly = increase - decrease
Lines of no Magnetic Variation
HUDSONS BAY
GREENLAND
ICELAND
NORTH SEA
BAY OF BISCAY
UNITED STATES
GULF OF MEXICO
CARIBBEAN SEA
PACIFIC OCEAN
SOUTH AMERICA
Tropic of Cancer
Equator
Shetlands
Faroe Is
Azores
C Verde Isles
Canary Is
Madeira
Bermudas
Halifax
Boston
New York
Philadelphia
Baltimore
Washington
Charleston
Mobile
New Orleans
Havana
Jamaica
Trinidad
Barbadoes
Antigua
Guadaloupe
Martinique
St Lucia
Grenada
Tobago
Curaçoa
Maracaibo
Para
Pernambuco
Bahia
Rio Janeiro
Montevideo
Buenos Ayres
Valparaiso
Lima
Panama
Galapagos
Cape Horn
Cape Farewell
Davis Strait
Hudsons Str
Frobisher B
Resolution I
Southampton Id
Baffins Land
Labrador
Newfoundland
Nova Scotia
Cape Breton I
Anticosti I
Belle Isle
Great Bank
Gulf of St Lawrence
Gulf of Florida
Bahama Is
Florida
Cuba
Hayti
Porto Rico
Virginia
Carolina
Georgia
Texas
Yucatan
Campeachy
Honduras
Mosquito Shore
Darien
Guiana
Amazon R
Orinoco R
Rio de la Plata
Magellan Str
Falkland Is
Terra del Fuego
Chili
Peru
Ecuador
Galapagos
Sandwich Land
Greenland
Iceland
Faroe Is
Shetlands
Orkneys
Aberdeen
Edinburgh
Dublin
Liverpool
Manchester
London
Paris
Bordeaux
Lisbon
Gibraltar
Madeira
Canary Is
Azores
Cape Verde Is
Sierra Leone
Cape Coast Castle
Fernando Noronha
Bahia
Rio Janeiro
Montevideo
Buenos Ayres
Cape Horn
Falkland Is
Tropic of Cancer
Equator
65° 95° 90° 85° 80° 75° 70° 65° 60° 55° 50° 45° 40° 35° 30° 25° 20° 15° 10° 5° 0° 5° 10°
60° 55° 50° 45° 40° 35° 30° 25° 20° 15° 10° 5° 0° 5° 10° 15° 20° 25° 30° 35° 40° 45° 50° 55° 60° 65°

One most important result of this movement was the appointment by the Admiralty of the late Captain E. J. Johnson as superintendent, in 1842, of the Compass Department. The great improvement in compasses dates from this appointment, and the investigation of the difficult and varying problems of local deviation have been since pursued by eminent men, among whom may be noticed Professor Airy, Dr. Scoresby, W. Walker, R.N., Archibald Smith, Esq., and many others. These researches have been mainly directed, as before observed, to the effect the ship's iron has on her compasses. Captain F. G. Evans, R.N., who has succeeded Captain Johnson, has drawn up a far more perfect chart of the geographic distribution of the magnetic variation than we hitherto possessed; former charts having become of impaired value from the lapse of time, and from the imperfection of the observations on which they were based. It is from this chart brought down to the period of 1879, by applying the secular change requisite to the chart of 1871, that the illustrative chart has been constructed.

(339.) The *isogonic lines*, or those upon which the variation is of the same amount, on this chart, will represent this element, generally as near as the ordinary ship's compass will show it, and will serve to draw attention to any unsuspected change in the magnetism of the ship, besides affording the sailor some information when observation cannot be had.

(340.) The *variation of the compass* in all parts of the coasts of the Atlantic are given with the Tables of Geographic Positions at the commencement of this work, and the amount of annual decrease or increase in this variation is also indicated. To these notices, therefore, the reader is referred.

It is for the open ocean that the illustrative chart and these notes are intended, and on the chart are inserted the amount of annual change in different parts, so that the approximate variation may be ascertained in future years by applying the necessary correction.

(341.) But it must not be supposed that this annual change is regular and of the same amount in each year. By the accurate observations that are now self-recorded, the connection between these changes and apparently very remote causes have been identified. One of these, at the first glance a very singular one, is that the spots in the sun, if absent or present in large quantities, have a marked magnetic influence on the declination, thus demonstrating the source from which the magnetism of the earth is chiefly derived. As the Greenwich observations will illustrate our subject as well as any, and this volume might be filled with interesting results on this subject, the notices will be limited to the extracts from those observations as being sufficient to impart a notion of the ever varying amount of the magnetic variation.

Westerly Magnetic Variation at Greenwich.

Month.	1844	1848	1850	1855	1860	1862
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
January	23 19 22	22 50 2	22 28 5	21 49 50	21 14 38	20 58 37
February	23 18 43	22 49 5	22 27 28	21 48 13	21 13 2	20 58 21
March	23 18 42	22 53 46	22 26 54	21 48 41	21 14 53	20 57 32
April	23 18 42	22 52 27	22 25 44	21 48 44	21 15 4	20 50 43
May	23 19 23	22 52 46	22 25 1	21 48 25	21 17 10	20 49 5
June	23 19 8	22 53 21	22 24 47	21 40 12	21 16 1	20 52 31
July	23 18 40	22 53 18	22 23 41	21 48 14	21 15 44	20 49 39
August	23 13 25	22 52 36	22 22 4	21 48 31	21 15 27	20 51 46
September	23 13 6	22 51 31	22 25 43	21 47 9	21 12 44	20 50 33
October	22 12 52	22 52 11	22 19 1	21 46 21	21 13 28	20 50 6
November	22 11 50	22 51 46	22 18 27	21 45 59	21 12 49	20 50 9
December	22 49 41	22 51 40	22 18 27	21 45 54	21 11 30	20 49 35

Table, *showing the Mean Monthly Westerly Declination of the Magnet and the Mean Monthly Dip from* 1865 *to* 1870.

Month.	1865	1866	1867	1868	1869	1870
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
January	.....	20 33 7	20 22 0	20 15 4	20 9 12	19 57 23
February	20 31 6	20 32 56	20 21 20	20 14 50	20 8 30	19 56 44
March	20 32 25	20 31 44	20 23 26	20 15 23	20 8 14	19 56 21
April	20 33 58	20 32 13	20 23 8	20 15 54	20 6 56	19 55 6
May	20 33 51	20 30 35	20 21 57	20 15 16	20 6 27	19 54 50
June	20 30 36	20 28 47	20 20 27	20 13 20	20 4 51	19 52 52
July	20 31 27	20 26 16	20 19 54	20 12 47	20 4 22	19 52 57
August	20 33 1	20 25 13	20 19 36	20 12 57	20 3 44	19 52 16
September	20 33 1	20 23 39	20 18 57	20 13 19	20 1 47	19 51 55
October	20 34 11	20 23 38	20 18 50	20 10 54	20 0 38	19 51 40
November	20 32 56	20 22 56	20 17 50	20 9 47	19 59 29	19 51 18
December	20 33 18	20 22 22	20 16 3	20 9 19	19 58 37	19 50 26
Means	20 32 43	20 27 47	20 20 17	20 13 14	20 4 21	19 53 39
Mean Dip	68 2 40	68 1 25	67 57 14	67 56 36	67 54 48	67 52 38

(342.) Upon examining these columns of figures, it will be at once seen that the decreasing amount of westerly variation is very far from being regular, and that at some times the variation is absolutely *increasing*. Thus, the variation in June, 1847, was 22° 43′ 0″; in June, 1848, 22° 53′ 21″, an *increase* of 10′ 21″. The *decrease* between January, 1846, and January, 1847, was only 1′ 38″; to January, 1848, 1′ 4″; to January, 1849, it decreased 14′ 6″; and to January, 1850, 5′ 51″; the mean annual rate for these four years being 5′ 44″. The variation in 1870 was about 19° 54′, so that it had decreased 3° 28′ 56″ in the twenty-six years that had elapsed since 1844, or at the rate of 8′ 0″ per annum; but its mean rate at Greenwich is about 8½, at present.

The needle also varies very considerably at times in the course of the day,

NORTH
ATLANTIC OCEAN
PASSAGES
HUDSONS BAY
GREEN
LAND
ICELAND
DAVIS STRAIT
LABRADOR
CANADA
UNITED STATES
GULF OF MEXICO
CARIBBEAN SEA
PACIFIC OCEAN
SOUTH AMERICA
NORTH SEA
BAY OF BISCAY
SPAIN
FRANCE
Great circle
Main route
Tropic of Cancer
Equator
Cape Farewell
Hudson Str.
Shetlands
Orkneys
Aberdeen
Edinburgh
Liverpool
Manchester
Dublin
Belfast
Cork
Plymouth
Portsmouth
London
Dover
Calais
Ostend
Amsterdam
Rotterdam
Hamburg
Bremerhaven
Brest
Bordeaux
Nantes
Rochelle
Oporto
Lisbon
Cadiz
Gibraltar
Madeira
Canary Is.
Cape Verde Is.
Azores
Bermudas
Halifax
Boston
New York
Philadelphia
Baltimore
Chesapeake B.
Cape Hatteras
Charleston
Savannah
Mobile
New Orleans
Tampa B.
Havana
Jamaica
Barbadoses
Trinidad
Tobago
Martinique
Guadaloupe
Antilles
Cape Horn
Falkland Is.
Galapagos
Fernando Noronha
Cape Roque
Rio Janeiro
Bahia
Pernambuco
Maranham
Para
Cayenne
Surinam
Demerara
Essequibo
Berbice
Barbadoes
Sierra Leone
Cape Palmas
Cape Coast Castle
Bight of Benin
Bight of Biafra
Gaboon
Cape Lopez
Cape Negro
Cape Blanco
Verde Isles
Gambia
Senegal
Goree
Mogador
Teneriffe
Canaries
Madeira
Azores
Bermudas
Labrador
Greenland
Iceland
Faroe Is.
Shetlands
Orkneys
Hudson Str.
Davis Strait
Cape Farewell
Great circle
Main route
Tropic of Cancer
Equator
From the Bight

the maximum westerly declination is at 2 p.m. This diurnal change amounts to 7′, 8′, 9′ and 10′. This topic is so large and comprehensive, that it must be left to other works devoted entirely to the subject, to afford further information.

V.—OF PASSAGES OVER THE ATLANTIC.

1. GENERAL REMARKS.

(343.) In the preceding pages we have described those natural phenomena of winds, currents, &c., which govern the track of a ship across the ocean.

The object of the present section is to apply these principles to the seaman's practice; but, previous to entering upon this portion of the task, we will make a few general observations upon great circle sailing, which has been revived as a new subject, when in fact it is one which was among the earliest principles recognised in navigation. This is not the place to enter into disquisitions on the working of great circle problems—that must be left to works specially devoted to nautical mathematics. The excellent "Practice of Navigation," by Lieutenant Raper, or Towson's Tables, published by the Hydrographic Office, will be found excellent guides; but still a greater simplicity in the application to ordinary purposes of navigation is a great desideratum, and one which, perhaps, we shall endeavour to supply at a future day.

Great circle sailing was known and acted on very early in the history of navigation. It is more than probable that Cabot, Columbus, Magalhaens, and all the first great navigators were acquainted with the subject;* but this, it must be remembered, was prior to the knowledge of the principles of finding the longitude. When Gerhard Mercator, in 1569, published a universal map, on the projection now known by his name, a new era commenced in navigation; but its true principles were not correctly described till they were done so by Edward Wright, in 1599. In this projection, as is well known, the meridians being parallel to each other, and straight lines, the latitude is distorted and decreased in proportion as these meridians are

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* It is alluded to directly in a work by Pedro Nunez, in 1537; again, by Pedro de Medina, in 1545; but his system was erroneous, and was corrected by Martine Cortes (or Curtis), whose work, "The Arte of Navigation," was soon after, in 1561, translated out of the Spanish into English, by Richard Eden, and was long the text book of British seamen. Numerous other works, in which it is correctly and distinctly described, afterwards appeared, as one by Michael Coignet, of Antwerp, in 1581; an excellent work by Roderick Zamarano, in 1585, &c. That by this time it was thoroughly recognised is evident by John Davis's Book, published in August, 1594, called the "Seaman's Secrets; wherein is Taught the *Three* Kinds of Sayling—Horizontall, Paradoxall, and *Sayling upon a Great Circle*." It is also described in Richard Polter's "Pathway to Perfect Sayling," about the same time. After this it is found in most of the old works on navigation.

more distant from each other than the correct difference of longitude would give for that latitude. Consequently a straight line drawn between any two points on such a plain chart, will give the correct compass bearing, which, if maintained throughout the course by a ship, will lead her from one point to the other. This course is well known as the rhumb course, and is that in universal use from its simplicity. But it is *not the shortest course*, except it be due East or West on the equator, or North or South on a meridian, which are great circles. This course, developed on a sphere, is found to be a *spiral*, and is considerably removed from a great circle or shortest distance if a great extent of longitude is traversed by it. We need not pursue this subject, but an example will explain its application.

(344.) From a point off the Lizard, in lat. 50° N., long. 5° 30′ W., to Cape St. John's, in the Bay of Notre Dame, in Newfoundland, also in lat. 50° N., and 55° 30′ W., the course, *true*, is of course *West*, and the distance on this parallel is 1,928½ miles. But if a ship were to quit the Lizard on a *N.* 70° 20′ 30″ *W.* (*true*) course, and then gradually bearing more westward, attaining the latitude of 52° 45′ N., in long. 30° 30′ W., thence bearing more southward, and approaching Cape St. John's on a similar angle to the parallel that she had left the Lizard, she will have sailed over 1,893 miles, or 35½ less than on the parallel; but, in her greatest separation, she will have been 165 miles distant from the rhumb course. Therefore, if she were to take any course between this great circle course and the parallel of 50°, she would have a less distance to traverse; and this is the great advantage which the great circle sailing offers—that of a wide range of choice (in a higher latitude) without increasing the distance.

Further, if she were to assume a course as much higher in latitude as the great circle course is above the rhumb, she will find that it will be of the same length as the latter. Thus, in the example cited, if on leaving the Lizard she were to bear away for a point in lat. 55° 30′ N., long. 30° 30′, and then approach Cape St. John's, such a curve will be found to be exactly 1,928½ miles in length, and yet be, in its maximum separation, 330 miles apart from the parallel. The advantage of such a range of choice will appear subsequently in the remarks upon the transatlantic passages.

(345.) The great difficulties in application of the principle of great circle sailing to practice are, the laborious nature of the calculations, now, however, much reduced, and the inference as to how a course so much at variance with that which the chart will apparently dictate as the most direct, will place a ship in respect to favourable winds or currents. Still, the scope it allows to the navigator must be considered as no mean advantage, even if its shorter distance may not be an inducement to rigorously follow out its principles.

(346.) In the following general sailing directions, the application of the facts in physical geography which have been described in the preceding sections of this work, must be left to the discretion of the commander in most cases. In fine weather, and with fair winds, the estimation of the various influences which affect the ship's course are not difficult to make. But it is the adverse circumstances of a voyage that call for the seaman's skill and intelligence, and what has been said will help him to form a judgment of what is going on and how best to proceed.

But there is an infinite variety of circumstances which render it impossible to lay down any fixed rule which may be implicitly followed to avantage at all times. Therefore, in cases where a definite course is pointed out as the best to be pursued, and a vessel should be driven out of her intended route, it does not follow that it is right to endeavour to regain that course to pursue it afresh, but rather it should be considered that a fresh voyage has to be commenced, and the course shaped from the latest point as if it were a starting point.

(347.) A vessel under steam only is considered in the light of a sailing vessel with a fair wind. In a certain sense this is true, as it enables her to be independent of wind or current. But it should be remembered that the same contrarieties which affect and hinder a sailing vessel from pursuing a direct course, will also, in a degree, be adverse to the progress of a steamer; and, therefore, if a moderate deviation from the shortest route will lead her into more favouring winds or currents, that course will be most advantageous to the vessel under steam as it is to the sailing ship.

There is one circumstance which may be mentioned respecting a ship under steam as to how she is affected by the direction and strength of the wind. If a vessel be steaming before a fresh breeze, strength No. 8, at the rate of 12 or 13 knots, she will experience a perfect calm, while the sailing vessel will be only able to carry her top-gallant sails and royals. If she steams in the teeth of the wind, she will seem to have a strong gale, under which a sailing ship could only carry close-reefed topsails. This will be made apparent by consulting the table of the velocity of the wind on page 180. Now, a vessel steaming with the wind otherwise than directly fore or aft, will not feel the wind in its true direction; for it will appear to blow from that direction and with that force which is a combination of the rate and direction of the ship's course with that of the velocity and direction of the wind itself. Its apparent and real course and velocity may be found by constructing a parallelogram of forces—a well-known problem. It is for this reason that the wind as registered on board a steam-vessel does not give the correct bearing of its course, and it is much more disguised than it is in a sailing ship when close hauled, as alluded to in (12), on p. 178.

As the steam-vessel, then may be considered in a great measure independent of wind and current, the great object of the past and succeeding remarks is mainly applicable to sailing vessels.

(348.) It has been well observed that the wind systems of our globe naturally govern the tracks of ships crossing the oceans, the trade winds carrying them from East to West within the tropics, while the anti-trade or passage winds will bring them back again eastward beyond the tropics. If it were not for the intervening belt of calms, sailing directions for vessels going into opposite hemispheres would be of the simplest kind; but the well-known equatorial embarrassments—"the doldrums"—generally make a very different matter of it, and cause many considerations to enter into the problem of shaping a course. In the North Atlantic, these obstacles of the intervening calms seem to be at their maximum, and in the future remarks one chief point, now still argued, will be found to be that which has engaged attention almost ever since over-sea voyages commenced—where is the best place to avoid these calms and contrarieties of the equator.

The directions which follow will commence with our own country, although very briefly; for it is presumed that almost every one who will use this book is either well qualified to navigate our own channels, or has more extended works on this point to guide him.

And even in the remarks on more distant voyages very brief notices would generally suffice, for most are now familiar with the varied particulars of the hydrography of the Atlantic as it affects a ship's passage. Notwithstanding the vast labour that has been bestowed on the research into its phenomena, it does not seem that a corresponding advantage has accrued to shipping; for in many cases the directions of a century since will be found as useful as those based upon these refined inquiries. However, one thing may be averred, that passages are now made with much greater certainty than formerly, and even if the average duration of a voyage is shortened a few hours, very much has been gained; and, by the comparison of a great number of voyages made under different circumstances, it may be safely pronounced which is the best course to pursue, and what the average length such a voyage will be.

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2. TO AND FROM THE ENGLISH CHANNEL.

Outward.

For vessels leaving the Downs, and having rounded the South Foreland, the track is W.S.W. 21 miles to Dungeness, the depth 20 to 10 fathoms. From a mile off Dungeness to abreast the Royal Sovereign Shoal Lightvessel, the course is W. by S. 24 miles, and in depths varying from 18 to 12 fathoms. In working down, and while to the eastward of Folkestone, stand in to 13 fathoms, and off towards the Varne to 16 fathoms. This latter bank has lost much of its dangerous character by the placing of the light-vessel, which marks its N.W. face. Between Dungeness and Bexhill keep outside of 9 or 10 fathoms, and within 25 fathoms. To the westward keep South of the Royal Sovereign Lightvessel, which will keep you clear of the shoals. Having arrived at 4 miles South of Beachy Head, a course may be shaped down Channel. This course will necessarily be much controlled by the wind and tide; but under any circumstances the English coast should not be left. If the wind be contrary, the best position with the commencement of the ebb is in shore. The flood tide, especially at its commencement, tends to the southward, filling the large indentations of the French coasts before it sets up the Channel, and then it sets on to the coast South of Boulogne. It is well to remember that the tidal streams throughout the fairway of the English Channel set towards Dover while the tide is rising there, and away from it while falling, so that the Dover tide-table answers for the whole distance between the Lizard and Beachy Head. H.W.F. and C. at Dover 11h. 12m. All this is explained on pages 304, 305, *ante*.

If the wind is favourable a W. by N. course for 60 miles brings you off St. Catherine's Point; from thence W. $\frac{3}{4}$ N. 94 miles to the Start. In working down do not come nearer the Owers than in 20 fathoms, and to St. Catharine's than 22 fathoms. From thence to St. Alban's Head into not less than 22 fathoms toward the indraught. Between Portland Bill and the

Start, if the weather be clear and favourable, you may stand into Lyme Bay to 17 or 16 fathoms. Throughout all this course keep off until in from 35 to 36 fathoms. From the Start to the Lizard, the course and distance are W. ¼ N. 64 miles, which course continued for 46 miles further brings the ship 10 miles South of the Bishop Light.

Throughout the course as far as off Plymouth, the tides set fair up and down; westward of this they revolve in all directions, and must be most carefully attended to, as is also most necessary when to the East of Beachy Head.

In case of bad weather or contrary winds, and necessity for shelter, the following places may be safely sought for. With the winds broad easterly or westerly, ships may stop on either side of Dungeness, in East or West, Bay, and also on either side of Beachy Head, in Seaford Road, westward and eastward of the shoals on the other side, and near Bexhill; and with westerly winds the Park inside the Owers Lightvessel is also used. Within the Isle of Wight there is anchorage sheltered from all winds. Westward of the Wight, Studland Bay (near Poole) affords good shelter from westerly gales. The Refuge Harbour in Portland Roadstead affords security against nearly all winds. Good anchorage is also found against southerly winds in Torbay, Plymouth Sound, and Falmouth.

Most sailors have had some experience of the detention caused by contrary winds in the English Channel. Some of the more remarkable of these detentions have long lived in remembrance. The Right Hon. Maurice Fitzgerald, in some evidence respecting the Western Harbours of Ireland, gave a curious illustration of the difficulties in making way against these westerly gales. An officer of considerable experience commanded a small vessel of war belonging to the Cork squadron. Information was received that a smuggler was to land on the western coast; he was ordered to cruise off the Skelligs to intercept her. He sailed from Cork, but was brought up six different times at Crookhaven, and, being extremely anxious to reach the ground upon which he was to cruise, he determined to sail round the North of Ireland, and he did so, and reached the Skellig in a very few days.

The detention of Rear-Admiral Christian was proverbially known. He sailed from Portsmouth with an expedition for the West Indies on Nov, 16, 1779, and, after having been repeatedly blown back, he did not ultimately clear the channel, till the end of the following March.

It seems that the wind generally draws up and down the Channel more or less, and does not blow true as in the open ocean. Thus, a westerly wind in the offing may become a W.N.W. wind in the English Channel, and a N.W. wind in the St. George's Channel; and the same with the easterly winds. By referring to (93), page 250, and the illustrative diagram, the reader will see some exemplification of this in the case of Liverpool, and in (97), pages 252, 253, those of the English Channel are discussed, where it will be seen that the western predominate over the eastern quarters as 229 is to 132. A new feature in our weather knowledge, which accounts for the prevalence of these westerly winds, will be found discussed on (92), page 249.

As a further illustration of the direction of the wind in the upper part of the Channel, we may adduce the following *resume* of 10 years' observations made by the Royal Society:—

TABLE OF THE WINDS OBSERVED AT THE ROYAL SOCIETY'S APARTMENTS IN LONDON.

	Easterly.	Westerly.		Easterly.	Westerly.
1820	102	168	1826	129	187
1821	91	196	1827	115	189
1822	101	181	1828	104	192
1823	99	189	1829	130	171
1824	81	195			
1825	97	188	Mean	101	186

Or, supposing a feather to have been abandoned at the beginning of each of these years, the mean direction and number of days the feather would have advanced is as below:—

Year.	Direction.	Days.	Year.	Direction.	Days.
1820	S. 86° E.	56	1825	S. 75°.8 E.	86
1821	N. 89° E.	92	1826	N. 58° E.	47
1822	N. 84° E.	72	1827	N. 58° E.	54
1823	S. 81° E.	81	1828	N. 39° E.	95
1824	S. 74° E.	91	1829	N. 57° E.	38

Mean for 10 years N. 85° E. 66 days per annum.

This shows how far the westerly predominate over the easterly directions. North-easterly winds are of a maximum in May and June.

Our remarks as to the lighthouses and other points of departure will be useful to a ship leaving dock to gain a sea-rate for her chronometers. In the geographical tables, pages 7 and 8, the chief land-marks are given to the minutest accuracy; and in the tables of lighthouses, the position of any one of the lights there given will equally answer as a point of departure.

HOMEWARD.*

The Bristol Channel I consider safer to approach than either the British or St. George's Channels. The parallel of Trevose Head, on which stand the two lighthouses, has been generally recommended, and that on the parallel of Lundy Island may be used according to circumstances, direction of the wind, &c. In thick or dark weather the soundings will indicate when you have passed a line cutting Scilly and St. Ann's Lights near Milford Haven, and also on nearing the shores on either side. The South side of Lundy is preferred, as you can go safely round it, taking care to keep the light in sight above the land; and as there are generally pilots lying under the island, you are sure not to miss them by pursuing this route.

For approaching and proceeding up the Bristol Channel, various directions have been given. 1st. *Soundings.*—The great difficulty is that the soundings

* General Notes on the Appproaches to the Channels and for Navigating the British Channel, by Captain Richard Leighton.

are very deep, and the same water may be got in different positions, both in latitude and longitude, so that a false position by dead-reckoning in the longitude, or in the latitude by the want of observations, is almost as likely to be confirmed as detected; I mean by *detached casts of the lead.* As a precaution against this, I would advise ships (particularly those navigating by dead-reckoning) to "seek the ground early," so that by striking the edge of the bank they may obtain, as it were, a departure, and then take frequent casts of the lead, and make with them a table in the following form, noting the true course and distance between each two casts, and carefully observing the quality of the ground as well as the depth of the water:—

True Course. | Distance. | Depth. | Quality of the Ground.

And where a few of these are obtained and set off upon the chart, one will check the other. Ships, as well as steamers, have been lost by not "*stopping to sound.*"

The prevalent winds are considered to be S.W. and westerly from May to December, both inclusive, and from January to April, both inclusive; although long and heavy S.W. and westerly gales may occur at this season, yet they are more frequently interrupted by northerly and N.E. winds, particularly in February and March. N.W. winds are considered to be generally of short duration.

To approach and pass Scilly, the parallel of 49° 15′ to 49° 25 has generally been recommended; in place of which I would recommend that from 49° 30′ to 49° 40′, according to the wind, &c., as likely to be attended with greater safety; and if the Bishop Rock or Scilly be not made, having taken every precaution to ascertain the longitude, once that its meridian is past, strike for the Lizard, and if possible, make it, and thence proceed by the rules of the best coasters. Lights can be seen when celestial observations cannot be made; and as the navigation is generally free from outlying dangers, courses should be shaped from one prominent point or light to the next, keeping at a moderate distance to ensure seeing them, if possible. The ships generally met with in this route are coasters, and they keep a good look-out, and are generally very anxious to get out of the way of large foreign-going ships.

Easterly Winds in the Winter and Spring Months.—Those winds are very destructive upon the East coast, and often cause heavy losses and great detention among the shipping; and, although they may blow long and steady in all the channel, yet at times they do not extend to the westward of Cork, but more generally about the edge of soundings; I have known them to blow long and remarkably steady in the Bristol Channel, and yet ships were arriving at Cork with heavy *S.W. winds.*

Whilst speaking of soundings and channel navigation, I want to strongly urge the use of Captain Sumner's method, as by it a single altitude giving the line A A with a cast of the lead, or a bearing of the land, will often fix a ship's position with certainty, and its many uses and advantages will soon suggest themselves after a little practice.

My reasons for dissenting from choosing the parallel of 49° 15′ to 49° 25′ to approach the channel, are:—

1st. A ship in this parallel will pass from 30 to 40 miles to the southward of Scilly, and will not expect to see it. I think this precaution attaches too much importance to Major Rennell's thwart channel current, which I do not

consider to be a definite current, but only at times occasioned by a combination of circumstances, driving a great excess of water into the Bay of Biscay, and the excess of tide to the northward does not require so great an allowance.

2nd. That parallel is the centre of the dangerous group of Guernsey, Jersey, the Caskets, &c., which, I believe, have caused more wrecks to ships bound up the British Channel than getting to the "*northward of Scilly*" has done, and the channel course trends to the northward, the difference of longitude between Scilly and the Caskets may appear great, but great errors occur in dead reckoning, and a ship goes far in a winter night and a westerly gale, but allowing them to avoid these dangers.

3rd. That parallel has led to or encouraged the imprudent and dangerous practice of galloping up in mid-channel, with neither anchor nor cable clear, and trusting to celestial observations and chronometers, as though it were in the middle of the Atlantic; and here we have the *Conqueror*, *Reliance*, &c., sad examples of the effects of not making and keeping hold of the English coast, lights, &c. A great deal was said and written about those cases, but I consider that the amount of error in the course and distance from a position off Scilly or the Lizard, to place a ship on shore between Boulogne and Calais, instead of being in a position off Dungeness, to be an *every-day occurrence* in navigating such a distance in tideways and blowing weather without any check to correct the account, and neither "storm-waves" nor "storm-currents" were required to cause them.

4th. Foreign-going masters generally keep at too great a distance from the land, by which they not only frequently miss a sight of lights, &c., which it is important that they should see, but they lose the benefit of some degree of familiarity with the land, objects, &c., which a nearer approach would give them, and which in the want of having to go into roadsteads, &c., would be found of very great service.

5th. It is not by keeping near the land that ships get embayed and lost. If it were, colliers would never be safe; they are as much afraid of getting off the land as foreign-going masters generally are of coming near it. The general rule in coasting is to see every guide as you pass it (unless thick weather should prevent it, and in that case strict attention to the lead until you find the next); this rule and attention to the set and duration of the tides are the grand points in coasting.

3.—TO AND FROM THE ST. GEORGE'S CHANNEL.*

"Many shipmasters have been bewildered in St. George's Channel, especially in thick weather, from ignorance of the tides and want of experience; some, we are sorry to add, from want of due consideration, and others from not allowing for the indraught into the bays on the Welsh coast, in which the two lightvessels are placed to remove some of this latter danger.

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* General Instructions and Admonitions for Vessels bound from Liverpool and other Western Ports to the Atlantic Ocean, and for Returning from the Ocean to the same; by Captain Thomas Midgley, of Liverpool.

"The writer of the following hints and observations begs to be understood as laying no claim to merit in their compilation; his only motive being to assist and advise the *stranger*, and those who, from want of experience, have acquired only a slight knowledge of this dangerous navigation."

Special caution to the effects of the tides seems necessary to be inculcated of late. Some most lamentable shipwrecks have recently occurred on the banks on the S.E. coast of Ireland, by vessels leaving Liverpool under what ought to have been favourable circumstances. The unthinking hardihood of the commander who will place his ship's keel on a special course as if it were a groove, which, if most accurately kept, will just shave clear of destruction, and without taking into account the numerous causes which will horse him off his course, such as bad steerage, leeway, heave of the sea, and, above all, the *set of the tides*—cannot be too strongly deprecated. And yet, as above said, some losses have occurred which have most certainly arisen from a culpable neglect of all these particulars, and been attributed to *charts* or local magnetic attraction unadjusted, or, indeed, anything but the real cause—the thoughtlessness of the sailor. On page 307 some brief remarks on the tidal streams of the St. George's Channel are given, which will do to remind the sailor of what is said in more extended works.

Another point of caution most important is, the character of the lights marking its dangers. In the table their present condition is given, and it is sincerely to be hoped that no misleading alteration will take place. Government official entanglements led to much confusion and unnecessary alterations in the Irish lights, which, as they were, or as they are, answer their purpose well; but unknown alterations must lead to confusion, doubt, and danger. Therefore, let the seaman who has been absent, perhaps for years, enter these difficult channels with all caution.

Captain Midgley's instructions are arranged as follows:—

(*a*) On proceeding from Liverpool westward to the Bay of Holyhead.

(*b*) On taking the North Channel, and proceeding thence to Tory Island.

(*c*) On proceeding by the South Channel, and thence westward to the ocean.

(*d*) On proceeding by the South of Ireland from the ocean to Liverpool, &c.

(*Throughout these remarks, the courses, bearings, and state of the winds, &c., are to be understood as by compass.*)

(*a*) On proceeding from Liverpool westward to Holyhead.

Liverpool being the principal and central port in St. George's Channel, and the prevalent winds being from the westward, W.S.W. and S.W., during eight or nine months of the year, I shall suppose that a large ship leaves that port, with an adverse wind from the westward. Having discharged the pilot off the lightship, stand to the northward all the ebb tide (which, in Liverpool Bay, sets to the N.W., and the flood to the S.E.), and, if laying N.N.W., or to the westward of this direction, during the first quarter of the flood, keep the lead occasionally going, with a careful look-out for the Isle of Man, which is moderately high, and on the South side bold-to.

Should there be a strong breeze and a heavy sea, the vessel may not weather the West Hoyle Sands, on the starboard tack; and great caution is, therefore required when going near them, as they are bold-to and very dangerous. In thick weather the lead must be constantly used, and the sands should not be approached nearer than in 10 fathoms of water.

The soundings along the North coast of Wales, eastward of Point Lynas, will pretty accurately determine the distance of the ship from the land, provided due attention be paid to the *depth* of water; but the *quality* of the soundings will not indicate the particular part of the coast she may be abreast of.

The *Ormes Heads* are very bold, and marked by a fine light, and any vessels may safely steer a direct course from thence to Point Lynas, which may be known by the castellated building near its extremity, used as a light-house, and its telegraph station upon the summit.

Point Lynas and the land to the westward of it is very bold, but the ebb tide hence runs very strongly to the W.N.W. and through the Sound inside the Skerries. Off the Middle and West Mouse the spring ebbs run at the rate of 7 knots; and all vessels should, consequently, give this part of the land a good berth, during light winds, at such times as the flood or ebb may be running strong; or they may, upon an ebb tide, get into the vicinity, or perhaps upon, the Coal Rock, the Skerries or Platters.

The Coal Rock bears E. ½ S. 2½ miles from the Skerries, and lies with the West Mouse (a large rock always high above water) on with the two beacons on Carnel Point. By night a *red* light from the Skerries will point out its direction. The Platters are nearly the whole length of the Skerries Rocks, and lie at about one-third of the distance between the Skerries and Carnel Point.

Beaumaris is a good harbour for all ships, into which a Liverpool pilot will conduct them, provided no licensed pilot for the port may be found; but the Beaumaris pilot-boat is generally cruising off the chops of the bay, between the Ormes Heads and Lynas, or lying at anchor within it.

Holyhead is also an excellent harbour, well sheltered by the Government pier.

(*b*) On taking the North Channel, and proceeding thence to Tory Island.

If, after weathering the Hoyle Sands, the wind should be so far to the southward of West as to enable a vessel to weather the Isle of Man, it may be a matter of consideration whether it be most advisable to go through the North or the South Channel, but this should not be hastily decided on. In the summer months the winds are more variable than in winter, and then it is certainly advisable to choose that passage which is nearest to the destined port, giving the preference to the North channel if bound to British America, Newfoundland, or the northern parts of the United States. In winter, the prevalent winds are from S.W. and W.S.W., and these winds often blow steady for several days.

Should the North Channel be preferred, with southerly and S.S.W. to W.S.W. winds (and it should not be attempted with any others that have

westing in them, especially by a stranger), it is advisable to take a departure from the Calf of Man, and steer a direct mid-channel course, with a careful look-out, as the passage is narrow and the tides very rapid, but running directly through the channel, the flood setting from the northward toward the Mull of Galloway. With a W.S.W. wind it will be necessary to keep the Irish shore aboard, after passing the two lights on the Maiden Rocks; or it is possible, in a strong gale from this quarter, that there may be some difficulty in weathering the Isle of Islay.

The North Channel is well lighted, and has many excellent harbours fit for the largest ships, as Lough Foyle, Belfast Lough, Loch Ryan, Campbelton, Lamlash, &c., but it is advisable for vessels, if possible, to take those upon the Irish coast, as they can get to sea with southerly and S.W. winds, when it may be difficult to get away from either Lamlash or Campbelton.

After passing Tory Island, do not be too anxious to make southing, but steer well to the westward, if possible; for there is always a very heavy sea and a strong indraught upon the West coast of Ireland, and strong westerly and W.N.W. gales are very prevalent in the winter. Although there are some excellent harbours in the N.W. of Ireland, they may be considered as inaccessible to a stranger, owing to the great difficulty of procuring a pilot in the winter season; every exertion should, therefore, be made to keep off this dangerous and too often fatal coast.

The depth of water, or quality of soundings in the North Channel, will give little or no indication of the progress of the vessel, so that a good look-out is here the mariner's best safeguard; the coasts on both sides being bold, excepting about the South Rock and Maiden Rock, both of which dangers are well lighted, but require a good berth in passing, particularly the latter.

In running through the North Channel with S.W. winds, every stitch of canvas should be carried that the vessel will probably bear, as these winds often fly suddenly round to the N.W. quarter, *see* (92); and in that case blow so hard, for twenty-four or thirty-six hours, as to compel a vessel either to bear up for the South Channel, take a harbour, or lie-to in a narrow and dangerous channel for a more favourable wind.

(*c*) On proceeding by the South Channel, and thence westward to the Ocean.

If it be intended to persevere in working down the South Channel, it will be the best way to keep the Irish shore aboard by short tacks, should the weather be squally with heavy rain, as the vessel will then have the benefit of the N.W. wind and smoother water, should it fly round to that quarter, as is often the case. In dry or moderate weather there is little fear of a sudden shift of wind; and a vessel, in such case, may make a long board toward the coast of Wales. Should it come on to blow from the S.W., with much rain, get the Irish coast on board as soon as possible, especially in the winter.

Vessels passing up or down the South Channel with westerly winds will find a strong indraught setting into Caernarvon and Cardigan Bays, as well as into the Bristol Channel; and this may be probably, in some degree,

accounted for by the following, and, perhaps, other causes:—Southerly, S.W., and westerly winds prevail over the Atlantic, between the Azores and Great Britain, during eight or nine months of the year, causing the surface-current in this vast space to flow to the eastward; the tides in the neighbourhood of, and to some distance westward of Scilly run nine hours of the twelve to the northward, or into St. George's Channel, which, like the Strait of Gibraltar, has some resemblance in form to the pipe of a funnel; and it is probable that, in gales of wind from the S.W. quarter, there is very little, if any, ebb from the western edge of Channel soundings to a position 15 leagues West from Scilly, and thence to the northward, on the same meridian, until within 15 leagues of the South coast of Ireland; neither do I think it at all unlikely that a portion of the stream of "Rennell's Current," which frequently, as I shall hereafter show, runs with velocity to the N.W., may be diverted by westerly gales into a more northerly direction, and being opposed in its course by the South coast of Ireland, finds its way to the eastward, and thus contributes to raise the level of the water, and make a strong tide or indraught into St. George's Channel.

This stream of tide sets E.N.E. toward the Tuskar, and nearly in the same direction, or a little more northerly, toward the Smalls, and rushes with great velocity, past Skokham and Skomer, through the sound, towards St. David's Head, and along the South and East coasts of Cardigan Bay, from whence it diverges toward Bardsey Island; in the Sound between which island and the main it runs with great strength.

It is generally advisable to keep the Irish shore aboard in turning down the St. George's Channel, with S.W. winds and heavy rain. In the South Channel the lead will impart some idea of the position of the vessel, or at any rate will indicate, by the depth of water, the probable distance of the vessel from the land. The banks on the Irish coast, between Howth Head and the Arklow Bank, may be safely approached to 20 fathoms of water, and nearer should it be clear weather, which, by-the-bye, is not often the case in this neighbourhood. When near the N.E. end of the Arklow Bank, and from thence to the westward, no vessel should shoalen her water under 28 fathoms, without daylight and constant caution. The lights on these banks require close attention, as they have at times been mistaken, which led to several alterations in their character a few years back. The tides of both flood and ebb run directly over these banks, in a N.N.E. and S.S.W. direction, and in light winds must be carefully attended to.

In beating to the westward, should a vessel shoalen her water on the coast of Wales to 30 fathoms, she will be quite far enough in-shore, and should tack immediately, for it should be recollected that there are 36 to 40 fathoms very close to Bardsey.

Should a vessel be caught with hard N.W. gales upon this dangerous coast, every exertion must be used, by carrying taut well-set sail, to get the ship round Bardsey, when she will have St. Tudwal's Road (which is well sheltered with westerly winds) under her lee. The fixed light of Bardsey is open to seaward only when it bears from N.E. $\frac{1}{2}$ E. to E. $\frac{1}{4}$ S. Should N.W. winds continue blowing hard, it will be better to run for St. Tudwal's Road, on the North, or to Fisgard Bay, on the South, than to persevere too long in attempting to work out of Cardigan Bay.

Any moderate-sized vessel may find good and safe anchorage in Fisgard Bay, by running in to 2 or 3 cables' lengths from the *Cow Rock*, on the West side of the entrance, and anchor when the land to the westward of it is shut in, and the rock bears N. by E., distant 4 cables' lengths. At this anchorage there is full five fathoms at low water, over a bottom of stiff clay and mud, which holds remarkably well, and the ship will lie well sheltered with all winds, except those from the N. around by the eastward to S.E. by E. or S.S.E. N.E. winds throw in a heavy sea.

The coast in the vicinity of Fisgard Bay is clean and bold, and the bay may be readily distinguished from the offing by the Cow Rock, which is always above water off the western point of the entrance, and by the remarkable appearance of Dinas Head (the eastern point), which, upon an easterly or S.E. bearing, exactly resembles the head of a large gurnet.

Were the advantages of Fisgard Bay more fully known, they would be duly appreciated. When the writer commanded the brig *Freeland*, of Liverpool, that vessel was disabled, by the loss of her sails, in the heavy N.W. gales which prevailed in December, 1833, and was obliged to run into this bay in order to save the vessel from a lee shore; and in this place she lay in safety, at single anchor, with 70 fathoms of chain, during the tremendous gales that caused the Liverpool lightship to part her moorings, and compelled her to run into the Mersey for shelter.

From what has been stated above, it will be seen that this bay is of easy access and egress, but it should never be used unless in a case of necessity, and then with a good and careful look-out at all times, and everything should be in readiness to trip the anchor at the moment the wind veers to the eastward of North, if the weather be not very moderate and settled.

On weathering the Smalls, when outward bound, it is advisable to keep well to the westward if the wind will permit, so as, on advancing southward, to give Scilly a wide berth—say of 18 or 20 leagues.

(*d*) On proceeding by the South of Ireland from the Ocean to Liverpool, etc.

In coming from the westward, many navigators endeavour to make the Fastnet Rock and Cape Clear, as it is high land, and has an excellent revolving light. The coast in the neighbourhood is also generally bold. But I do not think this is an advisable plan for a stranger, unless he has obtained good observations a very short time previously; for I have known vessels to be detained several days in endeavouring to work round the Cape against strong southerly gales and a N.W. current—unquestionably Rennell's.

In two of these cases, one in 1836, and the other in 1839, two different shipmasters ran with confidence for Cape Clear, upon the faith of good observations for latitude, taken forty-eight hours previously, and both made the *Skelligs* on the starboard bow, when steering E. by S., with the wind from the southward and S.S.W., thick weather and rain. When the Skelligs were near, one of these gentlemen considered his vessel to be on the parallel of the Cape, and the other (in 1839) thought that he was at least 10 to 15 miles to the southward of it. It may be proper, however, to add that the

latter denied the existence of Rennell's Current, until he thus found the effect of it.

In thick, hazy weather, it may be well to run upon the parallel of 51° N. until the vessel gets into 65 fathoms or less water; then steer E. by N. or E.N.E., keeping the lead occasionally going, and be careful not to advance into less than 40 fathoms, when a channel course of E. by S. may be shaped, having constant recourse to the deep-sea lead. By proceeding in this manner, it is probable that the land will be made in the vicinity of Waterford, or about the Saltee Islands, Waterford may be known by its lighthouse on the Hook Point, on the East side of the entrance of the harbour.

A little to the westward of Waterford are the THREE towers, on Great Newton Head, and TWO towers, upon Brownston Head, as described in the Sailing Directory. The latter are about 6 miles to the westward of the Hook Point of Waterford, and are too remarkable to be mistaken. The Saltee Islets are 4½ leagues to the eastward of the Hook Point, known by its tower and fixed light. The *Great Saltee* is high, and may be readily known by the Coningbeg lightship, moored to the S.W. of it. No vessel should attempt to pass between the light-vessel and the land if it can possibly be avoided, the passage between being rocky and dangerous.

The weather is often very thick on the Nymph Bank, with wind from the southward and N.W. quarter, and the Tuskar is, consequently, very difficult to make. The Smalls and Tuskar, on the opposite sides of the Channel, when seen in this thick weather, have often been mistaken for a large sloop with a peaked gaff-topsail set. No vessel should run with confidence up St. George's Channel without previously seeing one or other of the light-houses on these rocks, or the land in the vicinity, as the tides are hereabout very strong, and hidden dangers abound in the vicinity of both places, as shown by the charts. To the eastward of the Nymph Bank the weather generally becomes a little clearer than upon it.

The course may be safely altered when the Tuskar bears North, and an allowance of one point or more must be made for the direction of the wind, particularly if blowing from the N.W. quarter, as this wind not only increases the indraught into Cardigan and Carnarvon Bays, but it throws a heavy sea upon the whole line of the coast of Wales northward of St. David's Head.

In running from the *Smalls* toward Holyhead, it is, at all times, advisable to steer a point or more to the *northward* of the direct course, unless there is easting in the wind; and should Holyhead or the South Stack Lighthouse be made upon a bearing to the *northward* of N.E. by E. ½ E., the course should be altered a little, to bring it upon this bearing, otherwise the vessel may find some difficulty in weathering it upon an ebb-tide, if the wind should come out from the N.W. quarter, as there is a strong set (along the land) to the southward into Carnarvon Bay.

The island or rock called the *South Stack*, distinguished by its lighthouse, is very bold, but, with light wind and a flood tide, strangers should give it a berth of 3 or 4 miles, as there is much danger of being set inside the Skerries, if this is not attended to. In light winds and a flood tide steer well to the northward, until the Skerries bear E. by N., then gradually

edge away to the eastward, until the lighthouse bears E. by S., distant 2 miles, when the flood tide, with a very little assistance from the wind, will carry a vessel safely to the northward of it.

The Skerries may be approached by a stranger, on the North side, within a mile; and when the lighthouse bears S. by W., steer E. by N. 2 miles, and East 1 mile, or until the upper beacon on Carnel Point comes open to the eastward of the lower one, when the vessel will be clear to the eastward of the Coal Rock. On proceeding thence with a southerly wind, give a small berth to the Middle Mouse, a large rock always above water, and very bold. On steering thence toward Point Lynas, take particular care not to shut up the light if it be in the night. Should the light happen to be shut up, instantly run to the northward or N.N.E. until it opens, and heave-to or stand off and on for a pilot, about 4 or 5 miles to the eastward of the light, or between it and the Great Ormes Head.

In thick weather, after passing the Skerries, and at night if the light cannot be seen, great caution is requisite, in order to avoid the Coal Rock, and keep clear of the ebb tide running through the Sound; for, upon an ebb tide, the land between Point Lynas and the Skerries must not be approached within 3 or 4 miles without a commanding and favourable breeze.

Vessels bound to Liverpool should make signal for a pilot immediately after passing the Skerries, as the pilots are very often well to the westward, and keep a diligent look-out; but should no boat be seen, cruise about for one in the position before stated (between Lynas and the Ormes Head), as the tides here do not run strong; but do not, on any account, run a single mile to the eastward of the Great Ormes Head; for, should thick weather come on, the vessel will be in danger of being upon the West Hoyle or the Burbo Banks, and lost. It sometimes, but rarely, happens, when an unusual number of vessels come up on one tide, that there is no pilot-boat on the Lynas station, but it will only be left for a few hours, and vessels should wait with patience, for *here* a pilot is *sure* to be obtained.

The Liverpool pilots are under very excellent regulations, are exceedingly skilful in their profession, and in point of character and conduct are not surpassed by any similar body of men on the coast of Great Britain.

Although I have before noticed the necessity of an unremitting attention to the lead in thick weather, perhaps I may be excused for adding here, that such attention is of the *greatest importance;* as, owing to the velocity of the tides, it affords the mariner the only certain indication of his safety or danger, and contributes to relieve his mind in some degree from the anxiety he must feel whilst his vessel continues within the limits of this dangerous navigation.

4.—OF SHIPS BOUND ACROSS THE EQUATOR.

It is probable that there has been more discussion upon the route from the British Isles to the Equator, and on the best meridian for crossing the line, than upon any other passage. And yet the results of these inquiries as to this, the great highway of the ocean, have served to confirm in a great degree the opinions published in the early days of navigation, before any of the modern improvements and appliances had been brought to bear upon it.

The directions which were given by *M. D'Aprés de Mannevillette*, in his great "Neptune Orientale," published a century since, might be followed now without losing much of the advantages which deep study and extensive inquiry into data lately acquired, would give to the shipmaster.

Captain Maury at the time of the publication of his "Wind and Current Chart," in 1849, first advocated a more westerly crossing of the Equator than had been before pursued. This arose from looking at the voyage from the opposite side of the Atlantic to that on which all previous sailing directions had been composed. The configuration of the land about the equatorial portion of the Atlantic is peculiar, and causes the difficulties of a trans-equatorial voyage. The eastern point of the continent of South America, Cape San Roque, the "great bugbear" as Maury calls it, and the land about Pernambuco, lying in the strength of the S.E. Trade, and the consequent strong current to leeward which runs past it, were constantly the dread of the older mariners whose ships made so much leeway, and were incapable of sailing on a wind as our modern clippers do. But from the improvements in ships and their rig and management, much that was formerly insuperable is now quite practicable, and many of the difficulties of clearing Cape San Roque have vanished upon later inquiry.

The other difficulty which also combines with Captain Maury's argument, is the intervening belt of calms and moonsoons (which extends nearly across the ocean between the trade winds), which have a triangular form, the base lying upon the African coast, between Cape Verde and the Equator, and gradually getting narrower to the westward, and therefore by crossing them well to the westward they are traversed in a shorter distance, and their detaining effects are much less experienced.

The work of Captain Maury, although it has done good service, must now give place to those of Captain Toynbee, recently published by our own Meteorological Office.* In these the information is more reliable than that afforded by Captain Maury, not only by reason of the larger number of

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* (1) Charts of Meteorological data for square 3. Lat. 0°-10° N., Long. 20°-30 W., and Remarks to accompany the Monthly Charts, which show the best routes across the Equator for each month, &c. 1874.

(2) Charts of Meteorological Data for the Nine 10° Squares of the Atlantic, which lie between 20° N., and 10° S. and extend from 10° to 40 W. with accompanying Remarks, ending with the Best Routes across the Equator. 1876.

the observations from which they are compiled, but also because of the greater accuracy of the observations, all having been made with instruments tested and owned by the Meteorological Office. The period over which the observations extend, is mainly between the years 1855 and 1870. They were nearly all collected by the late Admiral Fitzroy from British ships of the Mercantile Marine.

Captain Toynbee in the introductory remarks of the latter of the two works (mentioned in the note on the previous page) says:—The part of the sea with which we are about to deal is of the greatest importance to the navigator, as it contains the much dreaded Doldrums, through which every ship bound to the southward of the Equator must pass; and it is no uncommon thing for ships to lose a fortnight or even three weeks, through taking a wrong route for the month."

In treating, therefore, of the third portion of this subject, or that which relates to the passage from Madeira to and across the Equator, we shall in the first place give Captain Toynbee's remarks, and afterwards such information from former editions of this work, as may be thought worthy of the sailors perusal.

For *Steam-ships* the Great Circle route from the Lizard to Cape Horn is probably nearly the best that could be followed, even if it were not the mathematical course. It passes near to the West end of Madeira and the Cape Verde Islands, as is directed for sailing ships, and then crosses the Equator in longitude 31¾° W. It almost touches Pernambuco and close to Rio de Janeiro towards the Strait of Le Maire, the total distance being 6,988½ miles.

Again the Great Circle route from New York to the Cape of Good Hope is a good route for steam-ships out or home. It cuts the Equator in 22° W. passing through Ascension and just westward of St. Helena, the distance being 6,877 miles.

To steam-vessels there will be no difficulty in following either of these nearest routes, and they will only be modified in sailing vessels by the force of the trade winds, which will make the course though the Trades more southerly than the Great Circle in going southwards.

Although a voyage round either of the great Capes—the Cape of Good Hope or Cape Horn—involves a more extended problem than that of the passage over the North Atlantic, with which this book especially deals, yet the difficulties and all phenomena which regulate the whole voyage are encountered North of the Equator, and therefore the discussion of the voyage to the Equator includes the whole problem, and what would follow for the South Atlantic is simply and easily followed.

The General Instructions for making the passage from the English or the St. George's Channels to the Equator may be briefly summed up as follows.—

1. From the Lizard or the Tuskar, steer W.S.W. to gain an offing, to longitude 10° or 12° W.
2. From thence steer so as to pass to westward of Madeira.
3. Thence to the West of the Cape Verdes, and across the Equator.

(Each of these portions of the voyage will be discussed separately.)

1. Leaving the Channel.

As has been said before, the Great Circle course from the Start to Pernambuco, commencing S.W. by W. ¼ W. (*S.* 37¾ *W. true*), carried on for 1,220 miles, takes to a point 30 miles West of Madeira, 15 miles outside Ushant and 55 miles off Cape Toriñana or Cape Finisterre.

With every circumstance in a vessels favour, this course made good may be followed; but, as will be seen by former discussions, she will be affected by numerous causes, which generally have a tendency to place her to the eastward of her course, and thus involve her among the dangers of the French and Spanish coasts.

A much more prudent course is at once to make your westing after leaving the entrance of the channel, as time will generally be saved by so doing, and all uncertainty avoided.

Therefore steer to the W.S.W. or S.W. by W. in *fine weather* after passing the Bishop Rock or the Lizard, until the longitude of 10° or 12° be attained. By doing this, the perplexing influence of the revolving tides which occur between the Start and the French coast, page 304, will be in some degree avoided. Again the uncertain Rennell's Current, pages 318—324, will less affect a vessel, or if strong, will assist her in making the necessary offing.

But the most important object, in thus early in the passage getting to westward, is to avoid the well known indraught into the English and St. George's Channels and the Bay of Biscay, see (178), pages 324—326. This westward tendency of the wind and current would, if not properly estimated, cause some difficulty in weathering Ushant, should the wind become at all adverse, and the strong tides, and dangerous navigation around these projecting headlands, render them very unpleasant neighbours.

It is probable, too, that the wind may veer more to the westward, as you get beyond the influence of the St. George's Channel in drawing it towards its more northern direction; and again, as westerly winds have a tendency to veer to the N.W., if you give plenty of sea room, you can pursue your course a point or two free. With the wind decidedly contrary to making a course to the South of West on reaching the chops of the channel, it may become a question as to how far a more northerly route is advisable.

In a discussion on the Packet Service about 1834, when a western port of Ireland was advocated as a better starting place than Falmouth, Sir Francis Beaufort drew up a comparison of 60 passages made by the Falmouth Packets, in contrary winds (30 outwards, 30 homewards), and what would have been the advantage had Cape Clear been the starting place instead of Falmouth, the desideratum being of course the safe weathering of Ushant and Cape Finisterre. Of course this was previous to the Steam Mail Service, and when the Falmouth packets were in a high state of efficiency, that is, from 1826 to 1830. Sir Francis Beaufort constructs the diagrams by laying off the tracks from Cape Clear of the vessels as if sailing with the same wind as that experienced by them in sailing from Falmouth. The average time occupied by the 30 outward packets from Falmouth to lat. 42° 40′, off Cape Finisterre, was 9 days 12 hours, varying from 12 days to 6 days. Had the packets started from Cape Clear, they could have

arrived at the same parallel in a mean time of 4 days and 21 hours, thus showing a saving of 4 days 11 hours, or nearly one-half. In the homeward route, the same mode of calculation shows that 4 days 9 hours may be saved in the same manner. Now, as Cape Clear is about the same distance from Madeira as the Land's End, it is evident that a vessel is in no worse a position by approaching it. Crookhaven, or some of the harbours on the S.W. side of Ireland, will afford her shelter as well as the S.W. of England.

This is said in case the vessel encounters strong head winds which will not allow her to make southing, which, after all, is the grand object, in order that you may quickly gain the N.E. trades. If the ship will not lay better than N.W. on the port tack, perhaps it is better to make a short board until the wind veers a little either way. If you are well to the westward of Ushant, and the weather moderate, supposing the ship will lay South or S. by W., you may safely stand on to the southward; but should the weather be threatening, and a westerly gale apprehended, it will be prudent to keep the Channel open, rather than by beating to windward, you get past Ushant, and thus embayed on the dangerous French coast, where also the wind is liable to shift close in shore. By keeping the English Channel under your lee, should you not be able to maintain your course, you may then run for some shelter.

2. Passage to Madeira.

When the ship is sufficiently to windward of Ushant or Cape Finisterre there can be no difficulty in making for Madeira, so as to pass within sight of it to the westward.

Cape Finisterre should be passed at a considerable distance, or, at least, the course should be so shaped as to do so, for fear of the prevalent drift which is frequently powerful along the North coast of Spain, and the effect of the prevalent westerly winds should horse the vessel to leeward and into the Bay of Biscay, which is especially to be avoided. The prominent headlands of the coast of Spain being now marked by a fine system of lighthouses, there is less danger of mistaking the country than there was formerly, as in many parts it is difficult to make out the bays and inlets, and of course it is a most dangerous iron-bound and lee shore.

By sighting Madeira an opportunity is afforded of testing the rate of the chronometers, as a sufficient interval will have elapsed to gain a sea rate, and having it thus early in the voyage will avoid much uncertainty in the subsequent passage. It may be stated that any point of the island will answer equally for giving a longitude. The tables on pages 39, 40 will give the positions of the most prominent points, or the description and chart hereafter will give further information.

It is better to pass 7 or 8 leagues off Madeira, as the winds are generally steadier particularly in winter. In November, December, and January, westerly gales prevail, which produce eddy winds and severe squalls near the land, occasioned by the mountains obstructing the regular course of the gales, and beside the weather here is very precarious.

However, notwithstanding all that has been said in former directions as to passing within sight of Madeira and the Cape Verdes, it is a question whether a more westerly course to the Equator may not be attended with some advantages. There is some reason to think that the nearer the land the more baffling and uncertain the wind is, and, as its tendency is to the westward, it is argued that some gain of time has been found to arise from crossing the parallel of 30° (as well as the equator) on a more westerly meridian than that of Madeira. The following abstract was made by Lieut. Maury in the former editions of his "Sailing Directory" (in 1855), and showed the number of days (average) that it took from lat. 33° to the Equator in the several crossings by 86 vessels :—

East of 16°			24	days from the mean of	6
Between 16°	and	17°	23	„	6
„ 17°	„	18°	24	„	14
„ 18°	„	19°	24	„	22
„ 19°	„	20°	23	„	19
„ 20°	„	21°	22	„	6
„ 21°	„	22°	21	„	7
„ 22°	„	23°	18	„	8

Thus, as the place of crossing the parallel of 30° is further to the West, so is the average passage thence to the Equator diminished. East of the meridian of 19°, the average passage, as far as the data of these tables may be relied on, is about 24 days. To the W. of 19° the ratio of decrease as to length of passage, according to this showing, is most rapid.

Captain Maury says the winds along this route are an exact counterpart of those that are found in the Pacific, on the route from California to Peru, Chili, or Cape Horn; for the deserts of Mexico and the United States hold very nearly the same relation to the N.E. trade winds of the Pacific that the deserts of Africa do to those of the Atlantic; and though quick runs may be made now and then, both along the West American and West African coast, yet, in the long run, experience in the Pacific has amply proved that the navigator saves time by keeping off from the coast, and so I apprehend it will be here. Indeed, experience in the Atlantic goes directly to show the same thing, and to place the opinion almost out of the category of conjecture, for this is the very point upon which the advantages of the new route from the United States to the line are based.

The passage to the line from England and the English Channel ought not on the average, to be as long by several days as it is from the United States. In the first place, the distance from the Land's End is not so great by two or three days' sail; and, in the next place, the winds are fairer. Vessels bound to the line from any of the Atlantic ports of the United States have to sail close hauled most of the way, but from Europe they go free.

If the performance of the ships whose abstract logs I have, which furnish the data for these tables, be a fair specimen of what ships generally do on this route, and I suppose it is rather above than below, it would appear that the average passage the year round to the line from England and the

English Channel is 36 days; the months giving the longest averages, such as they are, being January and March 47 days, August 46, and June 39. The first two are evidently too long, their averages being determined from only two or three passages each. The average to the line from the United States has been brought down from 41 to 31 days; and the average from the British Isles and English Channel can be, I am encouraged to believe, reduced to less than the American average; and the observations, to be contained in the abstract logs that shall be kept for us during the next year or two, will, probably, enable us to decide this question.

In the meantime, the route which I venture to recommend—not, however, without some misgivings, arising from the want of more ample data—is the same, very nearly, for all vessels from whatever part of Europe.

They should aim, whenever the wind will allow the option, to cross the parallel of 30° N., between the meridians of 25° and 30° W., but should not contend with adverse winds for it; having reached this crossing, their course thence is due South for the line, between the same meridians. In summer and fall they should enter the southern hemisphere about the meridian of 30°, but during the rest of the year they will generally not be forced so far over to the West, though they should not care to go East of longitude 25°.

Vessels from as far North as the English Channel should aim to cross the parallel of 40°, between the meridians of 20° and 25°; and for this reason—besides that of winds a little more propitious—viz.: In crossing the calms of Cancer the navigator wants to be in such a position that he may always be able to go on that tack which will carry him most rapidly across this belt of calms. In other words, he wants to be in that position where it is immaterial to him whether he be making easting or westing, provided he be on the tack which will give him the most southing. For this reason he should aim to enter the calm belt between longitude 25° and 30° W.

The average crossing place of 30° at present, is about the meridian of 19° W.

The above remarks of Captain Maury will be found useful as a guide in approaching the region discussed in the following section of our subject. Captain Toynbee's remarks will of course supersede those above given, relating to the crossing of the Equator.

3. Approaching and Crossing the Equator.

In the previous edition of this work, we had merely the experience of American and Dutch shipmasters as a guide in forming an opinion as to the best routes East or West of the Cape Verdes, and across the Equator. Now, however, that the valuable works of our own Meteorological Office have been published, as described at the commencement of this section (page 460), what formerly was the only guide, must be treated as a minor consideration, and is therefore only briefly alluded to hereafter (p. 476 *et seq.*).

The works (*note* p. 460) of the Meteorological Office to those with leisure

to properly study them, will be found both interesting and valuable. In the adjoining diagrams, of course, but a very brief description is given, compared with that in the elaborate charts which accompany the original works.

A warning is here given that the *direction* of the wind or current is only shown from that point at which it was most frequently observed, and the *force* of the wind or current from that direction alone indicated. Capt. Toynbee's remarks supply further detail, and will, we believe, make what is here given from these valuable works quite sufficient for the sailors requirement.

Square 3* lies so much in the highway of all ships passing to and fro, between the North and South Atlantics, that it contains nearly 60 per cent. of the 125,000 observations from which the charts are constructed.

In several of the squares the number of observations is so small that it would be useless to give them on monthly charts for each 2° square, as was done for square 3°, they have therefore been sifted into spaces of 2° of latitude by 5° of longitude. This method has the advantage of enabling us to represent a larger space on the same chart; and in most instances the spaces seem to be small enough to point out any differences which actually exist.

Captain Toynbee remarks:—"Having thus given a general view of the work we have in hand, I will now refer to the monthly diagrams, and also call attention to some interesting facts which have struck me in writing the remarks. Perhaps I ought first to say that in several instances the number of observations is so small that the isobars, isotherms, and wind and current arrows are not always so correct as a larger amount of data would make them; still in square 3 (which is the centre of the district) and in squares 39, 301, and 302, there is a large number of observations, so that the general result is satisfactory; for we find that the same month in different years has very much the same kind of wind and weather. I may add that though all data have been referred to the centre of the space to which they belong, it sometimes happens that nearly all the observations have been taken on one side of that space.

In the first place, then, it will be seen that we are dealing with a part of the sea where the two Trades are always meeting, though the latitude in which they meet varies with the season. This work therefore gives the meteorologist a constant opportunity for studying the motion of air where two air currents meet, and also the weather resulting therefrom.

Besides the meeting of two currents of air there are also two currents of water, which are mainly produced by the trade winds, and apparently increased in speed by the drift of water forced against Africa by the winter gales of each hemisphere; the direction of the trades tends to draw water away from the coast of Africa, and as the land prevents an influx of water from the westward, there is a third current or back drift to the eastward into the Gulf of Guinea to replace the water drawn away by the trade winds.

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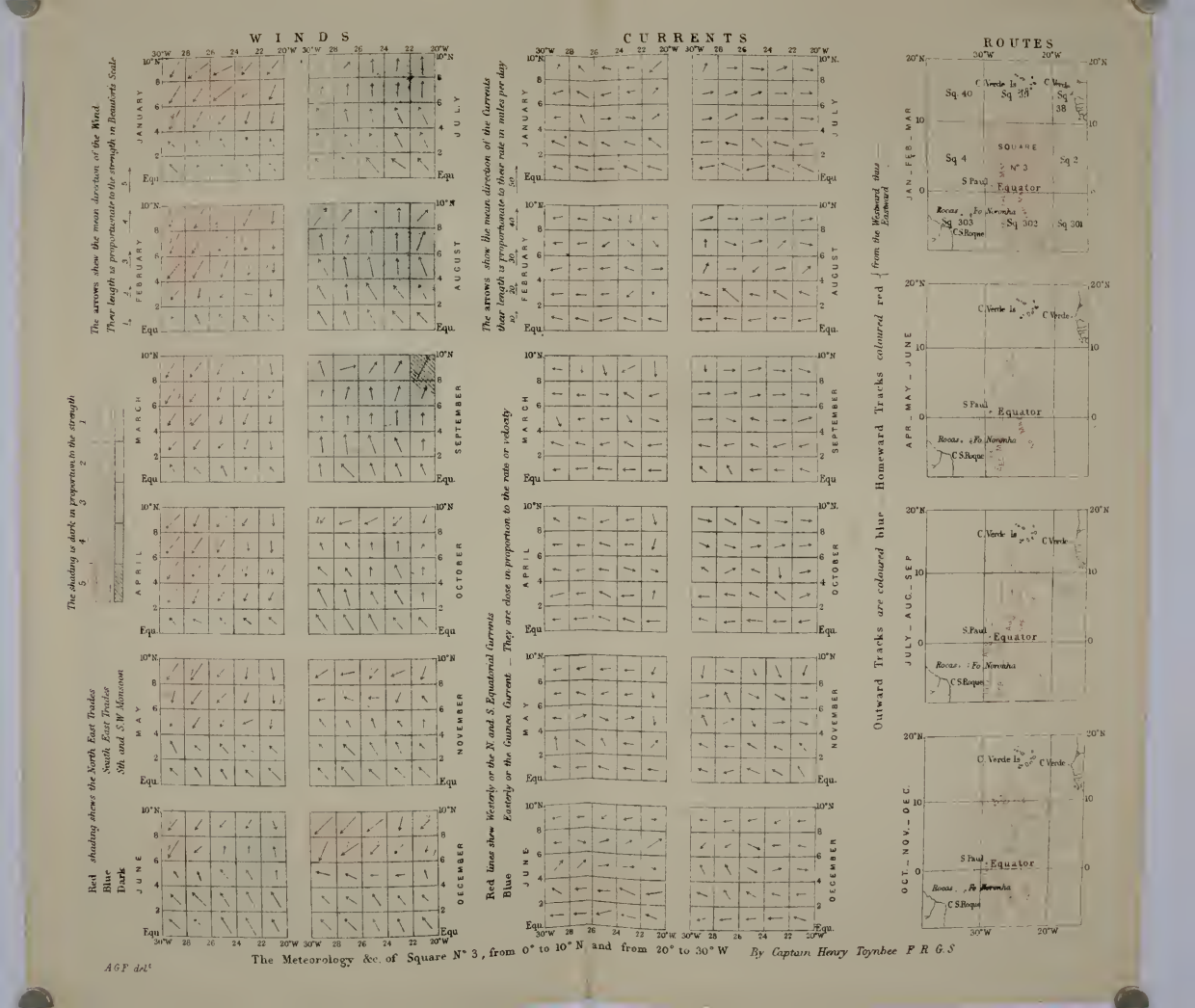
* The sea was divided into 10° squares, at the suggestion of Mr. Maudsley, formerly Secretary to the Admiralty, and the numbers then given to the various squares have been adopted by the Meteorological Office in their marine work.



The Meteorology &c. of Square N° 3, from 0° to 10° N and from 20° to 30° W By Captain Henry Toynbee F R G S

AGF del^t

This is the well known Guinea current, which seems to be chiefly the result of gravity.

It must be remembered that winds are named after the direction *from* which they come, whilst currents are named after the direction *towards* which they go; for instance, an arrow pointing to the north-westward represents a S.E. wind, but a N.W. current; therefore in the diagrams the *tails* of the wind arrows and the *heads* of the current arrows point towards the points of the compass after which they are named.

Remarks on *Winds*, of the regions under consideration, for each month are given in pages 203—207; on the *Currents*: North African Current p.328 330, Guinea Current 345—347, North Equatorial Current 357, the South Equatorial Current is described in pages 359—364. Beaufort's Scale of Wind (Force) is described on pages 179—180.

Best Monthly Routes across the Equator by Captain Toynbee, F.R.G.S., F.R.A.S., etc.

Although the following suggestions are considered to be the *safest*, when giving advice for all classes of ships, they are not intended to override a Captain's own judgment, for he has the advantage of knowing the qualities of his own ship.

Special attention is necessary in critical parts of the sea, such as that near Cape St. Roque, where at one season of the year outward bound ships are liable to be caught by southerly winds and leeward currents, and at another season of the year homeward bounders by light north easterly and northerly winds.

January.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, for although the wind is equally strong close to their eastern side in January, it is decidedly stronger on the western than on the eastern side of square 3.

Although the north-easterly wind prevails to the Equator west of the meridian of 30° W., and fast weatherly ships have done well after crossing the equator to the westward of that meridian, others have been hampered by the land, which is shown by the January wind remarks. A dull sailing ship which crossed the equator in 32° 45′ W. on December 13th, was 35 days before she cleared the land. The safest westerly limit for such a dull sailer is 26° to 27° W.

Referring to the eastern half of the January Wind Chart for square 303, and taking S.E. by E. as a central point; then when the wind is not from that point:—

Between 0° & 2° S. the prob. is about equal that it will either be more Sly or more Ely or N. Ely*

„ 2° & 4° S. „ 2 to 1 that it will be more Sly.

„ 4° & 6° S. „ 4 to 3 „ „

„ 6° & 8° S. „ 4 to 3 „ Ely or NEly

„ 8° & 10° S. „ 4 to 1 „ „

The January Chart for square 303 shows a prevailing westerly current of from 20 to 30 miles in 24 hours, and that it is stronger in the northern than in the southern half of the square. Exceptional currents, stronger than the means shown on the chart, are sometimes recorded. The chart for square 303 shows a large per centage of smooth sea in January. The above named facts, taken together with the qualities of his ship, will enable the navigator to decide on his best route.

Ships bound to the Northward should cross the equator between 25° and 30° W. so as to avoid the light north easterly winds which sometimes blow near the South American coast in this month, and also to pick up the fresh N.E. Trade, which prevails in that longitude between 4° and 6° N., but not further to the eastward.

February.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, as the western sides of squares 39 and 3 have stronger winds than their eastern sides. They should stand to the southward in about 26° W. and when they meet the southerly wind, take the tack which gives the most southing, endeavouring not to cross the equator to the westward of 28° W.

Referring to the eastern half of the February Wind Chart for square 303, and taking S.E. by E. as a central point; then when the wind is not from that point:—

Between 0° and 6° S. the probability is about equal that it will be more Sly Ely. or N.Ely.

„ 6° and 8° „ slightly in favour of its being more Ely. or N.Ely.

„ 8° and 10° „ about 2 to 1 that it will be more Ely. or N.Ely.

The prevailing current is still westerly, averaging from 20 to 30 miles a day, and generally stronger in the northern than in the southern half of the square. The chart shows that confused seas are not uncommon. The Remarks on Wind, for square 303, shows that ships which crossed the equator to the westward of 30° W. were not much hampered, but there seems to be no inducement to cross to the westward of 28° W.

Ships bound to the northward should carefully avoid the eastern side of square 3, where the north easterly wind is light, and there is much light north westerly wind, so should cross the equator to the westward of 25° and to the eastward of 30° W., by which means they will not get too near the

* In working out these probabilities all observations of wind from N. have been considered as north-easterly, and all from south have been considered as southerly. The few bservations from the western half of the compass have not been included.

coast of South America, where light north-easterly winds are not uncommon.

March.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, the N.E. trade being stronger on the western than on the eastern sides of squares 39 and 3. The March diagram shows that between 35° and 40° W., north-easterly winds prevail to the coast of South America, and to 2° S. between 30° and 35° W.

Referring to the eastern half of the March Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between 0° &	2° S.	the prob. is about	3 to 1	that it will be more	Ely. or N.Ely
,, 2° &	4° S.	,,	3 to 2	,,	,,
,, 4° &	6° S.	,,	3 to 2	,,	Sly.
,, 6° &	8° S.	,,	5 to 4	,,	,,
,, 8° &	10° S.	,,	5 to 3	,,	Ely. or N.Ely

The prevailing current in this part is still westerly, though now inclined more to the southward, and its rate from 20 to 30 miles in 24 hours; it is strongest between 2° and 6° S., weakest between 8° and 10° S. There is a large percentage of smooth sea in March. The Remarks on Wind in square 303 show that ships which crossed the Equator between 29° and 30° W. were hampered by the land; so that it seems best to cross the Equator in 27° or 28° W.

Ships bound to the northward should cross the Equator between 26° and 30° W., this will enable them to avoid the north easterly winds which are common in square 303, and, on the other hand, the light north-westerly winds and calms which are common on the eastern side of square 3.

April.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, for although the N.E. trade is as strong on the eastern as on the western side of square 39, it is much stronger on the western than on the eastern side of square 3; they should then stand to the southward in about 26° W., taking the tack which gives the most southing when the wind draws southerly.

Referring to the eastern half of the April Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between 0° &	4 S.	the prob. is about	3 to 1	that it will be more	Ely. or N.Ely
,, 4° &	6 S.	,,	5 to 3	,,	,,
,, 6° &	8° S.	,,	4 to 3	,,	Sly.
,, 8° &	10° S.	,,	3 to 2	,,	Ely. or N.Ely.

The prevailing current is still westerly at a rate of from 20 to 30 miles in 24 hours, exceptional currents being stronger, it is strongest between 2° and 8° S. There is a good deal of north-easterly swell in the north eastern part of square 303, and of smooth sea in its south eastern part. Near the South

American coast there is much light north-easterly wind, and it does not seem likely that a ship would have great difficulty in getting to the southward there, still the wind is lighter in square 303 than in square 302, and the Remarks in square 303, show that ships which cross to the westward of 30° W. are sometimes hampered, it would therefore be well not to cross the Equator to the westward of 27° or 28° W.

Ships bound to the northward should cross the equator between 25° and 30° W. so as to avoid the large amount of light north easterly wind which is recorded in square 303, and the light north westerly winds and calms which are common on the eastern side of square 3.

May.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, where the May diagram and chart show the wind to be stronger than to the eastward. In square 3 the north easterly wind prevails to 4° N. and is stronger between 25° and 30° W. than between 20° and 25° W.

Referring to the eastern half of the May Wind chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between 0° &	2° S.	the prob. is about	2 to 1	that it will be more	Ely or N.Ely
,, 2° &	4° S.	,,	5 to 3	,,	,,
,, 4° &	6° S.	,,	5 to 4	,,	Sly.
,, 6° &	8° S.	,,	2 to 1	,,	,,
,, 8° &	10° S.	,,	4 to 3	,,	,,

Form October to April the wind draws more easterly in the southern part of the square, but from May to November it draws more southerly. The westerly current is stronger than in previous months, and frequently exceeds 30 miles in 24 hours, it is strongest between 2° and 6° S. The sea is also higher than in previous months. It may therefore be well for a dull sailing ship to make a little easting after passing the Cape Verd Islands, more especially as the Remarks on Wind in square 303 show that the wind, weather, and sea near the South American coast are very trying. In one case the ship crossed the Equator in 26° 18′ W., but still was much hampered. Hence it seems right that a dull sailer should not cross the Equator to the westward of 25° W. in May. The Captain of a smart ship, when outward bound, may prefer keeping well to the westward and risking the detention near Cape St. Roque.

Ships bound to the northward should cross the Equator between 25° and 30° W., thus avoiding the unsettled wind and weather near South America on the one side, and the large amount of calm and light north west winds in the eastern half of square 3 on the other. The Diagram shows that the prevailing south easterly wind is stronger, as well as being more settled, between 25° and 30° W. than between 30° and 35° W., especially in the southern part of the district.

June.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, where the wind is stronger than to the eastward of them, and steer to

the southward in about 26° W., standing to the S.E. with first of the southerly wind which they will probably meet with in 6° N., and keeping on the starboard tack, if they can make southing, until they have made a fair amount of easting, as the "Remarks on Wind," in squares 302 and 303 show that the ships should not cross the Equator to the westward of 28° W., and it would be all the better if they crossed two or three degrees to the eastward of that meridian. Between 8° and 4° N. the prevailing current will probably be easterly, but south of 4° N. it is likely to be very strong to the westward; the requisite easting should therefore be made on getting the first of the southerly wind, as the S.E. trade becomes more easterly near the Equator.

Referring to the eastern half of the June Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between 0° & 4° S. the prob. is about 4 to 3 that it will be more southerly.
,, 4° & 6° S. ,, ,, 3 to 2 ,, ,,
,, 6° & 8° S. ,, ,, 3 to 1 ,, ,,
,, 8° & 10° S. ,, ,, 2 to 1 ,, ,,

So that, as in May, the wind becomes more southerly in the southern than in the northern half of the square, especially between 6° and 10° S. The westerly current in square 303 is still strong, especially in the northern half of the square where it frequently exceeds 30 miles in the 24 hours. There is much southerly, and even south-westerly, sea in June. In cases of ships crossing the Equator, all those in square 303 show the importance of crossing well to the eastward.

Ships bound to the northward should cross the Equator between 25° and 30° W., so as to avoid the unsettled wind and weather, which are more extreme near the South American coast than further to the eastward, and on the other hand to get a more steady N.E. trade after passing 6° N. than exists further to the eastward.

July.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, where the N.E. trade is stronger than to the eastward. On getting the first of the southerly wind, in about 10° N., they should stand to the south-eastward, making all the requisite easting in the northern part of the southerly wind as it draws more easterly near the equator. Between 10° and 4° N. they will probably experience an easterly current, but this will help them to the windward, and place them in a better position for dealing with the very strong westerly current which prevails, after passing to the southward of 4° N.

Referring to the eastern half of the July Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point:—

Between 0° & 2° S. the prob. is about 2 to 1 that it will be more southerly.
,, 2° & 4° S. ,, ,, 3 to 1 ,, ,,
,, 4° & 6° S. ,, ,, 5 to 1 ,, ,,
,, 6° & 8° S. ,, ,, 6 to 1 ,, ,,
,, 8° & 10° S. ,, ,, 3 to 1 ,, ,,

Showing that the wind is much more southerly than in June. The wind is more southerly in July than in any other month. The westerly current in square 303 is still very strong, especially in the northern half of the square, where the mean of four or five observations is sometimes 35 miles in 24 hours! There is also much southerly sea in July. The "Remarks on Wind," square 303, give cases of ships which had crossed the Equator to the westward of 30° W., getting hampered by the South American coast. The wind is also much more squally and unsettled in square 303 than in the squares to the eastward of it, so that ships will do well not to cross the Equator to the westward of 25° to 28° W. in July.

Ships bound to the northward may be guided very much by the longitude in which they approach the equator; those from the eastward may cross between 20° and 25° W., as the southerly winds are slightly stronger on the eastern than on the western side of square 3, but they should be in 25° W. when in 10° N., so as to get a better N.E. trade than that which exists further East. Ships from the westward would do well to cross the Equator and stand to the northward in about 30° W.

August.

Ships bound to the Southward should pass to the westward of the Cape Verd Islands, where the N.E. trade is stronger than to the eastward of them. On getting the first of the south westerly winds in about 10° or 12 N. they should stand to the south-eastward, not fearing the effect of the easterly current which prevails between 10° and 4° N., as a pretty strong westerly current may be expected to the southward of 4° N. The diagram shows that the prevailing southerly wind becomes more easterly as the equator is approached so that the requisite easting should be made with the first of the southerly wind, and as the winds near Cape St. Roque are more southerly and unsettled than they are further to the eastward, it is important to cross the Equator well to the eastward, say in 25° or 26° W., or even two or three degrees further to the eastward.

Referring to the eastern half of the August Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between	0° & 6° S.	the prob. is about		2 to 1	that it will be	more southerly.
,,	6° & 8° S.	,,	,,	5 to 1	,,	,,
,,	8° & 10° S.	,,	,,	2 to 1	,,	,,

The wind is still remarkably southerly between 6° and 8° S., off the most eastern part of South America. The westerly current is still strong; strongest in the northern half of the square. Southerly and confused swells are very frequent. The "Remarks on Wind," square 303, give cases of ships that were hampered by the South American land; one, a fast iron ship, having crossed the equator as far east as 27° 22′ W.

Ships bound to the northward should avoid the South American land, as the wind is lighter to the westward of 33° W. than it is to the eastward. They should be in 25° W., or further W., on crossing the parallel 10° N., as the N.E. trade is stronger and extends further S. on the western side of the district than it does near the Cape Verd Islands.

September.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, where they will have a better N.E. trade than to the eastward. On getting to the south-westerly wind in 10° or 12° N. they should stand to the south-eastward; that wind, with the prevailing easterly current, will carry them fast to the eastward, but the diagram shows that to the southward of 4° N. the prevailing wind is south-easterly, and the current westerly, which will carry them fast to the westward.

Referring to the eastern half of the September Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between 0° & 2° S. the prob. is about 3 to 1 that it will be more southerly.
,, 2° & 4° S. ,, ,, 2 to 1 ,, ,,
,, 4° & 8° S. ,, ,, 3 to 1 ,, ,,
,, 8. & 10° S. ,, ,, 2 to 1 ,, ,,

The prevailing current is westerly from 20 to 30 miles in the 24 hours, the difference of its speed in the northern and southern halves of the square is not so great as in previous months. The sea is still very southerly and confused. The "Remarks on Wind," square 303, give cases in which ships were hampered off the South American coast; in some cases after crossing the Equator in 27° W., so that it would be well to cross in 26° W. or further to the eastward.

Ships bound to the northward are not likely to meet with north-easterly winds near the coast of South America, still it seems well that they should cross the equator to the eastward of 30° W., as the winds in square 4 are lighter than those in square 3. The eastern and western sides of square 3 seem to have equally good winds for getting to the northward, but it may be well for the ships from the eastward to cross the Equator in about 25° W., as the winds are stronger on the western than on the eastern side of square 39.

October.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, where the N.E. trade is stronger than to the eastward, and steer S. until they meet the first of the southerly wind in or about 8° or 7° N., then stand to the south eastward until the wind changes, so that they can make the most southing on the port tack. The prevailing current is easterly between 10° and 6° N., but westerly further to the southward.

Referring to the eastern half of the October Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between 0° & 2° S. the prob. is about 3 to 1 that it will be more southerly.
,, 2° & 6° S. ,, ,, 2 to 1 ,, ,,
,, 6° & 8° S. ,, ,, 4 to 3 ,, ,, E. or N.E.
,, 8° & 10° S. ,, ,, 4 to 1 ,, ,, ,,

Here, for the first time since April, the wind gets more E. or N.E. in the southern than in the northern and central parts of the square. The current

is still westerly from 20 to 30 miles in 24 hours, and stronger in the northern than in the southern half of the square. Southerly seas are very frequent in the southern part of the square. The "Remarks on Wind," square 303, give cases of ships crossing the Equator in 30° W., or further W.; all but the last were hampered by the land, so that 28° W. seems a safer limit in October, though the Wind Chart and Remarks show that the winds near South America are more favourable for getting to the southward in that month than they have been since April.

Ships bound to the northward whilst S. of the equator will find stronger winds between 25° and 30° W. than in any other longitude; after crossing the Equator they will find the southerly wind stronger and the N.E. trade stronger and more easterly in that longitude that they are further to the eastward.

November.

Ships bound to the southward should certainly pass to the westward of the Cape Verd Islands, for although the diagram shows that to the southward of 16° N. the *prevailing* wind is slightly stronger in the western half of square 39, the amount of calm is greater in the eastern, especially between 14° and 16° N.; and the mean force of *all winds* is greatest in the western half. After passing the Cape Verds it may be well to haul slightly to the eastward, so as to be in 25° W. when in 6° N., and then with the first of the southerly wind to take which gives the most southing, endeavouring if possible not to cross the Equator to the westward of 29° W. A slight easterly current will probably be experienced between 10° and 4° N.; in other parts it is likely to be westerly.

Referring to the eastern half of the November Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between	0° & 2° S.	the	prob.	is about	5 to 3	that it will be more southerly.
,,	2° & 4° S.	,,	,,	equal	that it will be more southerly or easterly, or north easterly.	
,,	4° & 6° S.	,,	,,	2 to 1	that it will be more easterly or north easterly.	
,,	6° & 8° S.	,,	,,	5 to 1	,,	,,
,,	8° & 10° S.	,,	,,	11 to 1	,,	,,

In November the tendency in the wind to become more easterly or north-easterly in the southern part of the square is very decided. There is still a westerly current of from 20 to 30 miles in 24 hours, and sometimes it exceeds 30 miles; it is strongest between 2° and 4° S. The per-centage of south-westerly current is greater in the southern part of the square than in previous months. Smooth seas are much more frequent than in previous months, especially in the southern part of the square. The "Remarks on Wind," square 303, give cases of ships which crossed the Equator in 30° W. or further W.; all, excepting the last two, made very fair passages to 10° S., one, a dull sailer with light winds, whilst the other, though a fast ship, was very much hampered, but she crossed the Equator in 33° 50′ W.;

so that a good sailing ship need not fear crossing in 31° W. if driven to do so by circumstances.

Ships bound to the northward should cross the Equator between 25° and 30° W., as by doing so they will avoid the lighter winds which prevail near the South American land on the one side, and also those which exist in the eastern halves of squares 3 and 39 on the other, beside getting a more easterly N.E. trade.

December.

Ships bound to the southward should pass to the westward of the Cape Verd Islands, where although the wind is much more easterly than it is to the eastward of them, it is decidedly stronger. On the eastern side (between 14° and 16° N.) the wind chart of square 39 shows that there is 15 per cent. of calm. These ships should haul a little to the eastward after passing the islands, so as to take the first of the S.E. trade in about 25° W. or slightly further E., then take the tack which gives the most southing. The prevailing current is westerly throughout this route, and, as the diagram shows, averages 25 miles in 24 hours near the Equator, so that a dull sailer, which is not weatherly, should make rather more easting before getting S.E. trade.

Referring to the eastern half of the December Wind Chart for square 303, and taking S.E. by E. as a central point; then, when the wind is not from that point—

Between 0° & 2° S. the prob. is about 3 to 2 that it will be more easterly or north-easterly.

,,	2° & 6° S.	,,	,,	2 to 1	,,	,,
,,	6° & 8° S.	,,	,,	3 to 1	,,	,,
,,	8° & 10° S.	,,	,,	6 to 1	,,	,,

In December the tendency for wind to be more easterly or north-easterly than S.E. by E., when not from that point, prevails throughout the square. The current is still westerly, averaging from 20 to 30 miles in 24 hours, and sometimes exceeding 30 miles; it is strongest in the northern half of the square. There is still much smooth sea in the southern part of the square. The "Remarks on Wind," in square 303, give cases of ships which crossed the Equator in 30° W. or further W., they all had to tack off the land, and would no doubt have done better if they had not crossed to the westward of 29° W. One ship was so hampered by southerly winds and westerly currents near South America that she stood to the north-eastward, and *re-crossed the Equator* to make easting, not getting to 10° S. before 25 days after her first crossing ! !

Ships bound to the northward should cross the equator between 25° and 30° W., thus avoiding on the one hand the lighter winds which prevail near the coast of South America, and on the other the light winds and calms which are more common on the eastern than on the western side of square 3. On the western side of square 39 the winds are very favourable for going to the northward, but quite the reverse on its eastern side.

We will now give a few extracts from the information, on this subject, which appeared in former editions of this work.

East or West of the Cape Verdes.*—With regard to this subject, the Royal Netherlands Meteorological Institute and the Meteorological Institute of Utrecht have done good service to the mariner in their excellent publications. The latter office published a table of the times and crossings of 455 Dutch vessels from the Channel to the Line. To this list the Americans added the sailings of 144 vessels, many of which are probably clippers, so that there was the experience of these 599 vessels to appeal to in the choice of the route in this part of the voyage.

Number of Vessels, Dutch and American, and their average time from the Lizard to the Line, by the passage East and by the passage West of the Cape Verde Islands.

	AMERICAN.				DUTCH.			
	East.		West.		East.		West.	
	Days.	Vessels.	Days.	Vessels.	Days.	Vessels.	Days.	Vessels.
December	29.5	4	27.	4	32.1	11	33.6	16
January	28.5	3	31.5	6	31.5	17	31.	17
February	27.8	2	28.9	11	35.3	9	32.9	11
Average and sum	28.6	9	29.1	31	32.9	37	32.5	44
March	29.7	3	30.5	6	36.6	5	30.5	15
April	24.2	1	26.1	8	31.8	23	28.7	39
May	32.1	5	31.8	12	33.2	9	32.	84
Average and sum	28.7	9	29.5	26	33.9	37	30.4	88
June	36.7	2	29.7	17	32.5	4	33.1	37
July	34.5	3	30.6	9	35.5	4	33.9	53
August	30.2	2	34.5	11	35.4	4	33.8	38
Average and sum	33.8	7	31.6	37	34.5	12	33.6	128
September	42.4	2	33.3	14	36.3	9	36.2	31
October	33.2	4	32.	10	32.4	9	32.9	24
November	29.7	3	32.	3	36.8	10	36.8	26
Average and sum	35.1	9	32.4	27	35.2	28	35.3	81
Total average and sum	31.5	34	30.6	111	34.1	114	32.9	341

It appears that the passages East are uniformly longer for the Dutch, except in December, January, June and October; and that for the American they give the shorter averages for January, February, March, April, August, and November. But the averages for these are derived from an insufficient number of passages, only two or three, fourteen in all, for each month.

* It will be seen in the above remarks that Captain Toynbee in no month recommends the route eastward of the Cape Verdes.

There is a difficulty here in estimating the relative value of the American and Dutch results, as we do not know what the class and sailing powers of the two fleets were; but it is probable that the superiority of the American tracks would not be so great, if the Dutch had selected vessels of an equal class for the comparison. However, it would seem that there is certainly some few hours' detention on the average by going inside the islands, compared with the outer passages contained in the foregoing Tables.

Captain Sir Edward Belcher, in his outward voyage round the Cape of Good Hope, in the *Samarang*, March, 1843, diverged from the "beaten track," with considerable advantage. His reason for so doing was, that by crossing the Equator 10° or 15° more eastward than is usually done, when arrived in the parallel of St. Helena, he would be many miles to windward of the usual route. "Having always considered the eastern route the preferable, I attempted, on my homeward voyage, in H.M.S. *Sulphur*, to reach Porto Praya direct from Ascension. In this, however, I failed, owing to the occurrence of westerly breezes driving us toward the African coast, until in the parallel of the Cape de Verde Islands, which proved that from the Cape de Verdes, southerly, towards the Equator, in the month of June, favourable breezes without calms might be reckoned upon; and I was reminded that ships coming from Ascension and St. Helena generally make good passages, passing to the westward of the Cape de Verdes. My experience, while employed on the African station, taught me that a fair passage from the Cape de Verdes to Sierra Leone, or the coast easterly, could always be anticipated, and that no retarding calms are to be met with on the verge of the African soundings. Vessels also from the African coast, seeking Ascension for change of climate, find this remark applicable, and it might be fairly assumed that if we could reach the Equator under light airs and moderate breezes in a less number of days than the average passage to 24° West longitude (the increased distance being impeded by many days' calm), and by crossing to the eastward of the tenth degree of West longitude, the westerly current would be avoided, and we should be able to fetch to windward of Ascension, or possibly sight St. Helena, many hundred miles to windward of the 'beaten track.' The result proved as anticipated. Leaving Porto Praya on March, 7th, we experienced light and moderate breezes, with *south-easterly current*. Between the 7th and 21st of March, or from Porto Praya to the Equator on the ninth meridian of West longitude, we averaged 81 miles per day, and experienced no more than 10 hours calm. Before the south-westerly breezes quitted us, we had been carried as far as 8° West. After light south-westerly airs, we were enabled, on the 28th of March, by a succession of breezes from the S.E., to pass 150 miles to windward of Ascension, in 9° 44' E., arriving in Simon's Bay Cape of Good Hope, on April 25th."—*Voyage of the Samarang*, pp. 7, 8.

This passage, which takes advantage of the easterly Guinea Current (pp. 339—347), will be more specially alluded to hereafter. If a West African port should be sought, of course the advantages are on the side of the inner passage; but this, as said above, will be alluded to presently.

As each portion of the passage over the Atlantic is, in a great measure, dependent on the other, it cannot be pronounced on absolutely whether, of itself, one part of a course can be most advantageously pursued in a certain direction. In the next ensuing paragraphs, this problem will be considered in connection with the further progress of the voyages.

Crossing the Equator.— As this question stood for some years, it was that to cross the Equator in 30° W. was the best route in all seasons. In 1848, Lieutenant Maury published his Wind and Current Chart of the North Atlantic, upon which he marked the great circle track joining New York and long. 31° W. on the equator, distance 3,370 miles, and upon this track was the following:—"The distance by the route usually pursued is upwards of 4,100 miles. Outward-bound vessels are recommended to try this route to Rio Janeiro. The tracks of vessels on this chart show the average passage from the United States to the Line to be 38 days, and to Rio 55 days. There is reason to believe that the prevailing winds along the (great circle) route here indicated will be found more favourable—steadier and stronger than they are by the usual route, and the distance is nearly 1,000 miles less. Hence I respectfully invite the attention of navigators to this route, under the expectation that, by taking it, they will shorten their passage several days."

By the chart on which this note is placed, it seems that the practice of the American ships was to run down to westward between 34° and 40° N., and cross the parallel of 30° between 30° and 38° W. Naturally a better course would suggest itself, and the great circle course is that which would stand prominent. Captain Maury having received much encouragement by the adoption of an approximation to this track, to the great advantage of American voyages over the former easterly track, argued strongly on the advantages that would be gained by the route from Europe being made to cross the Equator on the same meridian (about 30° W.).

Of the vessels mentioned in the table on page 476, it is shown that the mean longitude of the American crossing is 26¼° W., while the Dutch is 22¾° W.; and yet the contrast between their passages is not so great as the difference in the position with regard to the equatorial calms or "doldrums" would seem to warrant an inference. It may, therefore, be advised generally that the meridian of 26° W.* is a good crossing, and that, if further West, it is questionable whether any advantage is gained.

In an able discussion of the logs of several clippers in the "Mercantile Marine Magazine," the same conclusion is independently arrived at. "We have yet to learn if the most favourable crossing be *westward* of 25° W. for English vessels outward-bound to the East. The passage by the *eastward* of the Cape Verdes has been strongly recommended, as shown by the preceding extracts, and it is certainly worth attention that the best passage recorded in that article was made by a vessel (the *Lady Raffles*), which run down her southing eastward of the Cape Verdes."

Captain H. Toynbee, F.R.A.S., F.R.G.S., also discussed the westerly crossing of the Line, as tried by him in his well-known ship, the *Gloriana*. This voyage was made in October, 1858, and the Line was crossed in 30½° W.

"On the 2nd of October, 1858, the *Gloriana* was in lat. 17° 43′ N., long. 26° 29′ W.

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* This has proved correct within 1°, as will be seen by referring to Captain Toynbee's remarks. His monthly routes are all between 26° and 28° W.

From this position, being West of the Cape Verde Islands, *I endeavoured to make a true South course* when the wind was fair, and preferred the tack which gave the most southing when it was foul.

From the 2nd to the 7th we went on well, for on the latter date we were in lat. 7° 29′ N., long. 27° 52′ W., having been driven by the wind and about 38 miles of current, 83 miles further West. From the 7th to the 15th we had 'doldrums.' Until the 10th, when we were in lat. 6° 25′ N., long. 26° 57′ W., the weather was chiefly fine, with a mixture of northerly and southerly swells; after that, heavy rain squalls, looking very threatening, but not sufficient wind to require the royals to be taken in, with a high southerly swell. During the whole time the wind was from East round by South to West, but chiefly South; the current was generally to the eastward from 11° to 5° N.

"Oct. 15th.—Lat. 4° 8′ N., long. 25° 41′ W.; current in the last 24 hours West, 16 miles; wind S. by W., by compass; variation 17° W. This was the point where I had to decide whether to steer to the eastward, making a little northing, until I considered my ship far enough to windward, or to the westward, making about W.S.W., with the certainty of a westerly current. I chose to go to the westward, feeling sure that the wind would gradually draw to the S.E., whereas I think that, had we gone to the eastward, we should have continued in the variables, if we did not run back into calms.

"Oct. 16th.—Lat. 3° 15′ N., long. 27° 22½′ W.; course and distance, S. 62½° W., 114 miles; current in the last twenty-four hours, N. 39° E., 12 miles; variation, by azimuth compass, 17° 3′ W., by steering compass, 16° 3′ W. At 10 a.m. a large ship passed us steering to the eastward, and we lost sight of a barque which was in company, so I suppose that she also went off to the eastward. The wind drew to the South by compass, so that we were able to make true S.W. ½ W. The weather during the last twenty-four hours looked unsettled, especially in the N.W., where there was lightning; but even when we broke off to W. by N. for an hour, I felt that, by going on the port tack, we were drawing into the S.E. trade.

"Oct. 17th.—Lat. 1° 30′ N., long. 29° 24′ W.; by * lunar, 30° W.; course and distance, S. 48½° W., 162½ miles; current, S. 77½° W., 13 miles. The wind from S. by E. to S.S.E.; the sea smooth, and weather very delightful.

"Oct. 18th.—Lat. 0° 52′ S., long. 31° 24′ W.; by * lunars 32° W.; course and distance, S. 41° W., 184 miles; current, S. 44° W., 12 miles. The wind from S.S.E. and S.E. by S.

"Oct. 19th.—5 a.m., lat. per meridian altitude of Sirius, 2° 32′ S.; noon, lat. 3° 15′ S., long. 31° 56′ W.; current, S. 13° W., 8 miles; wind, S.S.E. ½ E.; bearing and distance of the Rocas, supposing them to be in lat. 3° 55′ S., long. 33° 44′ W., and taking the mean of the above longitude as my position at noon, S. 38° W., 51 miles. 3 p.m.—Lat., per meridian altitude of Venus, 3° 33½′ S. 3.20 p.m.—Long., per altitude of the sun, using the London rates for the best chronometer, 33° 10½′ W. Hence, since noon we had made S. 36° W., 25 miles.

"Throughout the afternoon we steered about S. 35° W., and at 5 p.m. we saw the reef about 12 miles off, extending from nearly right ahead out on the weather bow; and at 6 p.m. we kept away W.S.W., so as to pass it at the distance of about 5 miles.

"The sighting the Rocas was one of very many instances in my experience proving the look-out man, either from want of practice or from feeling a want of interest in what he was doing, unable to see an object almost staring him in the face. From 3.30 p.m., I ordered a regular look-out from fore-topsail yard, and at 5 p.m. felt so sure that the reef must be in sight, that I determined to visit the topsail-yard myself; when, on stepping into the rigging, something strange caught my eye, which proved to be a beacon on the western part of the reef; yet from the topsail-yard the look-out man had seen nothing, and could hardly see it when I pointed it out. A similar

case happened one evening on our way towards Torres Straits, when I sent an officer up to look round as the sun set, though I always kept a man on the fore-topsail-yard He quickly saw a long line of broken water right ahead, it being part of Lihou Shoal, extending further to the eastward than it was laid down either in charts or books. I find that in moderately fine weather, when observations show that the land may be sighted, a good night-glass on the forecastle and a patent lead are first-rate safeguards; indeed, tho three L's are all right enough, but much depends on the quality of these said L's.

"Now it remains to be decided how we should have fared if on the 15th we had stood to the eastward, making easting, with a little northing, until we thought ourselves far enough to windward. In our present case we certainly had to tack off America (though it is the first time in my extreme westerly routes that I have had to do so), yet in two days we beat 111 miles to the South and 27 to the East, and cleared the difficulty. It would not be right, however, to tempt ships near reefs and land unless they gain by it; and merely by a comparison of my own voyages of other years at the same season I should condemn this route, for I never did worse from 10° N. to the equator than this year. Once at the very same date I passed between the Cape de Verdes and Africa. Then we were 13 days from 10° N. to the Line, but were not troubled near South America and had a better S.E. trade. This time we were only 12 days, but lost a day near South America. In October, 1852, I passed 10° N. about 2° further East within a day or two of our date, and was only 8½ days to the Equator, which we crossed in 20° W., having been carried into 18° W. by a strong S.W. monsoon, which turned into the S.E. trade without a calm. Still, this probably was an exception, and I should like and shall try to see the logs of some ships which passed through the Doldrums with us.

"September 25th, 1856, and October 15th, 1857, I crossed the Equator much in the same longitude as this year—that is, 30° W.; in September passed 25 miles to the westward of Fernando Noronha, and in October still nearer, and both voyages we weathered America with ease. Once in May I crossed the Equator between 28° and 29° W., and could not weather America, *but was much bothered off Cape St. Augustine.*

"Again, from Cape St. Augustine to the Abrolhos, the ships which pass far West do not seem to do so well as those which go far to the eastward. For instance, as I am now writing on the 26th of October, we have done but S. 14° W. 51½ miles, and on the 25th, S. 23° W. 85 miles. For all this, one feels inclined to blame the westerly route; at any rate until it is proved that the ships which went to the eastward have done as badly or worse than ourselves.

"The conclusion I am inclined to draw from all this is, that in October, when once your ship is so near the Equator as to expect the S.E. trade, and the wind sets in from S. by W. by compass, go on the port tack with the yards sharp up, and keep well full; then the wind is almost certain to turn into the S E. trade, with beautiful weather. My experience would lead me to say that in October, when you are below 5° N., with a steady S. by W. by compass wind, you have the commencement of the S.E. trade, and should stand boldly on the port tack; but I am not yet decided as to how a ship ought to steer after passing to the westward of the Cape de Verdes, though I think as we have done this year; that is, due North, with a fair wind, and the tack on which you make the most southing with a foul; because the probability is, that you will have a S.W. monsoon, which will drive you well to the eastward. If there were not this probability I would have a ship in October steer to get the S.E. trade, or rather the S. by W. wind, in about 20° W., for if she does not get into the latitude of Cape St. Roque quite so soon, I think she will be in a better position by the time she loses the S.E. trade."

In a subsequent discussion, when Captain Toynbee had procured the logs from other ships of similar class which left the channel at the same time, the *Gosport*, which

was also West of the Cape Verdes on the same day, bore to the S.E., crossing the equator in 25° W., and reaching 20° S. a week before the *Gloriana*. The *Alfred*, which pursued a similar course to the *Gloriana*, crossing the Line in 32¼° W.; and the *Vernon* and *Octavia*, which passed inside the Cape Verdes, crossed the Line in 25° and 26° W.

"The first question raised is—Was the *Gloriana* right in steering due South on the 2nd when the wind was fair? The *Gosforth's* track says no, she ought to have steered S.S.E. until in 25° W., and then to have made a little easting with the southing whenever it was possible. But the tracks of the ships (*Vernon* and *Octavia*) which passed East of the Cape de Verde Islands, say on no account go to the eastward of 22° W. This advice is only applicable when the wind is light and variable; of course, if a S.W. monsoon is experienced in these parts a south-easterly course must be followed until the wind draws to the South.

"On looking at these tracks I suppose Maury's correspondent, Captain Windsor, would say that the captain of the *Gosforth* is 'one of those men who are kicked through the world in good luck to keep them out of harm's way,' or how could he have had a run of 184 miles between the 5th and 6th of October, when ships to the right and left of him did but little more than half that distance in the same time? Not being a believer in luck myself, it seems to me that the little easting he made from the 2nd to the 9th placed him in a position by which he was enabled to keep off the coast of South America, and so avoid the light winds from the 24th to the 26th which affected all the ships North of 20° S. Here my *second query* is answered, for we find that the westerly crossing of the Line was not the cause of the light winds we experienced on the 25th and 26th; or, to be more explicit, the ships several degrees East of us suffered from them to the same extent as ourselves.

The *Alfred* and *Gloriana* have given the extreme westerly route a fair trial. They started from 20° N., differing one day in their dates, and on the 23rd of October, after passing Cape St. Roque, the *Alfred* was in the same position as the *Gloriana* had held on the 22nd.

The extreme eastern route between the Cape de Verde Islands and Africa was fairly tried by the *Vernon and Octavia*. It is manifestly wrong for the early part of October, for they lost much on the ships which took the western route.

"Considering the positions of the four hindmost ships on the 28th of October, I am inclined to think that the *Gloriana's* is the best, for to get South of the calms and variables near the tropic of Capricorn is more important than to make easting, so much so, that, when there, I chose the tack which gives the most southing. Hence the readers of my last paper on the subject will see that this research proves that we were better off than most of our neighbours, and no doubt the commanders of the other ships will examine this chart with great interest.

"It will be noticed that the *Gosforth's* track ends on the 21st, so that although, where it commenced, she was but a trifle more than half a day in advance of the *Gloriana*, she ended with an advance of seven days. Thus she gained on the *Gloriana*, 6½ days; *Alfred*, 7¼; *Octavia*, 8½; *Vernon*, 9½.

"The conclusion I draw from this is, that early in October neither the extreme eastern nor the extreme western route is good. Therefore, a ship should pass West of the Cape de Verde Islands, and then, when the wind will permit, haul to the S.E. when South of them, so as to be about 23° W. when she is 5° N., she should then take the tack which gives the most southing.

"Maury's 'Sailing Directions' support this opinion. The averages he deduces from the table in page 148 of the 2nd vol., dated March, 1859, plainly prove that the extreme western route is a disadvantage in October. And, again, the American part of the table in page 457 shows that ships should not go East of the Cape de Verde Islands in October, though it is contradicted by the Dutch part of the same table, with more ships to take an average from. Still, most of the nine Dutch ships may

have passed East of the Cape de Verdes much later in October than the Americans; at any rate sound reason seems to support the middle route, for if a ship works her way to the South in the longitude of the Cape de Verdes she is more likely to get a spirt of the S.W. monsoon, which sometimes blows at this season, and avoids the certain calms of a more easterly course, as also the danger of being detained a day or two near Cape St. Rogue by the more westerly route.

"From the end of October to February I would pass East of the Cape de Verde Islands, and perhaps also in March and April. Early in December we took this route, and were on the Equator on the 23d day from England.

"A few tracks similar to these for each month in the year would soon decide the best route."

We are unwilling to omit those instructions which have appeared in our former editions, and which for nearly a century directed almost all the European shipping; but, of course, what has preceded will supersede them where they differ. Still much is good to the present day, and may be followed advantageously.

M. D'Apres de Mannevillette, in his Directions from the English Channel to the East Indies, says, "When you steer out of the Channel, you ought to shape your course so as to pass Cape Finisterre at the distance of 25 or 30 leagues; this distance," he adds, "will be sufficient, in whatsoever season of the year your voyage may happen; you may indeed double that cape still nearer, if circumstances require but, from its latitude, you should always shape a course for the Island of Madeira.

"Though a sight of that island is not indispensably necessary in this passage, it is proper, however, to gain a sight of that, or of the Island of Porto Santo, that you may be able to keep on your course afterward with greater certainty, whether you pass between the Canary Islands, or leave them to the eastward, as may be judged most convenient.

"In the passage from the coast of France to the Canaries, you may frequently find differences in your reckoning to the eastward, which arise most probably from the indraught of the currents toward the Strait of Gibraltar: some have made the land on the coast of Africa when they expected to have discovered Tenerife; others have gained sight of Allegranza, off the northern part of Lanzarote, instead of Tenerife; and, though the errors in reckoning may not frequently be so considerable, yet it is safer to be on your guard, when you judge by your reckoning, that you are in the latitude of these islands, especially in the night-time, or when the want of moonlight, or very thick hazy weather, prevents you from discovering dangers at such a distance as to be able to escape them.

"The differences to westward, though much more rare, are yet not without example; chiefly when the winds have hung contrary for some time after the departure from the ports of England or France.

"Ships are, however, now generally recommended to pass to the westward of the Canary and Cape Verde Islands; it having been found that, in this route, steadier winds may be expected than those generally prevalent close to or among the islands. On the African coast, W.S.W. and S.W. winds are frequent. The track now generally adopted by ships having chronometers is that to the westward of all the islands.

"Should it be required to touch at Senegal or Goree, the best course will be to make the coast of Africa near Cape Blanco, lat. 20° 55′; as there are soundings at 5 or 6 leagues off the coast, and no danger in making the land, either by day or night, provided the lead be kept frequently going; and thus you may steer up to the cape.

"Though it may seem natural enough not to suspect any errors of consequence in your reckoning in so short a passage as from the Canaries to the Isles of Cape Verde, yet there are instances of such, as well to easting as to westing. It is with respect to errors in our westings, that I advise all vessels to keep 30 leagues to windward of Bonavista, before they stand in to make the land; lest, in keeping a direct course for that island, they should pass between the Isle of St. Nicholas and the Isle of Sal; and, finding themselves to westward of Bonavista, when they reckoned themselves to be still to eastward of it, they should miss their refreshments at the Isle of St. Iago, an accident which has happened to several vessels.

"The making of these islands is often difficult, occasioned by the fogs which hang frequently around them. For this reason, those who come from the northward ought to steer their vessels in this track with all possible precaution.

"The most convenient course for vessels which continue their voyage from the Canaries, without touching at the islands of Cape Verde or Goree, is to steer, after they lose sight of the Canaries, so as to pass about 45 leagues West of Cape Blanco, or near the meridian of 20°; from this position they will make good their course due South, as far as 12° N., and afterward S.E. by S., till they meet with those variable winds which succeed to the trade winds. By this they will keep the mid-channel between the islands and Cape Verde, and coast along the bank below that cape, at a sufficient distance, even though they should make an error in their reckoning of 15 or 20 leagues to the eastward.

But as, when the sun is near the northern tropic, the trade wind has been often found to fail within the sight of the Cape Verde Islands, it has been recommended to ships, at these times, to pass the islands to the westward, at the distance of about 10 leagues, in order to preserve a steady wind, and prevent delay, by keeping clear of the light eddy winds, which then prevail near and among the islands. When to the southward of these isles steer to the S.E., so as to get between the meridians of 18° and 23° W., upon losing the N.E. trade wind. Should the southerly winds then commence, advantage may be taken of the shifts to stand on the tack which will gain most to the southward, so as to cross the Equator between the longitudes above mentioned, if the wind will permit. Be cautious of making a long tack, either eastward or westward, with a dead southerly wind, in the hope of having a better, unless the wind should veer, so as to produce much southing.

The S.E. trade wind, at its northern limit, generally inclines far to the southward, particularly in July, August, and September, but frequently in other months. A ship meeting this trade should not be kept too close to the wind, but keep clean full, in order to make good way to the S.W., and clear of the southern limits of the westerly current that generally prevails about the Equator.

It has been already shown, in the description of currents, that ships, passing the line too far to the *westward*, run the risk of not been able to weather the coast of Brazil. But *M. D'Apres* has observed, that there is not one instance to prove that, by passing the Line to the *eastward* of the limits above mentioned, ships meet with calms of a long duration, and currents setting with great rapidity toward the River Gaboon, as had before been generally imagined.

M. D'Apres adds, "Vessels which sail from St. Iago should steer S.E. as far as the 12th degree of latitude; after that S.E. by S. Those which depart from Goree should steer S.S.W., if they desire to keep clear of the shore, till they reach the parallel of 10 degrees, thence their course should be S.E. by S."

His words on crossing the Line are, "When the variable winds succeed the trade winds, the best method of crossing the Line with speed is, to take advantage of the

very first variable winds, for gaining the ordinary track of the trade winds, so soon as you possibly can; and for this end, to keep indifferently to that tack which bears most to southward, without troubling yourself about crossing the line at any determinate point, lest you make your voyage longer than is necessary.*

On the Return toward England, in crossing the N.E. trade wind, a ship's sails should be kept well filled, to enable her to gain speedily to the northward. In this track the Sargasso or gulf-weed will be met with in the *Sargasso Sea*, and which is sometimes found as high as 41° N.

Beyond the northern limit of the trade wind, ships generally cross the parallel of 33° N. in from 39° to 42° W., in order to make use of the southerly and westerly winds which prevail here more than they do to the eastward.

Should the wind veer to the N.W. on approaching toward the Azores, you may pass through one of the channels of these islands, and thence pursue a course to the English Channel, according to circumstances.

It is not advisable to pass to the eastward of these islands, because adverse winds often prevail from the northward between them and the coast of Portugal; and the currents are also generally unfavourable to this route; yet it has sometimes happened that ships passing this way have, with S.W. and West winds, reached the channel sooner than those which have proceeded to the westward. With these S.W. and westerly winds, you must be cautious in approaching the channel, in case the current should prevail which sometimes sets athwart it, as before described.

5.—ROUTES TO AND FROM THE SENEGAL AND GAMBIA.†

Whatever may be the season of the year, it is advisable to gain an offing of 25 leagues to the westward of Cape Finisterre; from hence it may be immaterial whether a course be shaped to the eastward or westward of Madeira. A commander desirous of touching at the Canaries will adopt the former, and will shape a course for Teneriffe, having nothing to apprehend on this course but the Salvages, the position of which has been well determined. In the Canarian Archipelago the winds are mostly from North to N.E. If the course to the westward of Madeira be adopted, a vessel will make the westernmost of the Canaries only, and her place may be rectified by a sight of Palma or Ferro.

But a sight of the coast of Africa is by no means necessary for vessels bound to the Senegal or Goree. What has been said of the currents and prevailing winds in this navigation, leaves no doubt that it is perfectly useless to make the land more than 15 or 20 leagues to the northward of the Senegal, when bound to the Bar-anchorage. This digression is the utmost

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* Capt. Maury says:—"No sailing directions can be given for these calm belts, except such as are contained in these emphatic words:—"MAKE THE BEST OF YOUR WAY ACROSS THEM WITHOUT REGARD TO LONGITUDE." To which may be added, that nearer to North and South the course is, the better, as it crosses their direction at right angles.

† Abridged chiefly from the Baron Roussin.

which should be made from the above course; and by means of the lead, and some few latitudes carefully observed, it might even be made a direct one. On leaving Teneriffe, the course should be S.W. ¾ S. (*S. by W.* ½ *W.*) as far as the parallel of 21°, then S. by W. ¾ W. (*South*) as far as 20°, and from thence S. by E. ¼ E. (*S.E. by S.*) without any further alteration.

The first course will carry a vessel more than 25 leagues from the nearest point on the African coast, and in a track where no danger has been found. The second will conduct her 36 leagues to the westward of the westernmost point of the Bank of Arguin. By the third she will make the coast in the neighbourhood of the *Marigot or Lagoon of Mosquitos* (lat. 16° 35½′), from whence she may coast the shore until abreast the Senegal, in 15° 55′ N.

If it be found necessary to make the land during the night, the lead, being the only means of correcting the estimated run, should be used frequently and with great care. At about 10 leagues from the shore to the northward of the Senegal, a bottom of white sand will be found, with 70 fathoms. From thence the depth gradually decreases towards the shore, and at 1 mile from it there are 7 or 8 fathoms. When in 15 fathoms of water, it is advisable to anchor until daylight, to avoid running past the bar, which has no distinguishing mark by night.

There is a source of error attached to the navigation of the African coast, which must be carefully guarded against. It is the optical illusion caused by the great horizontal refraction, which renders any correct estimation of distance almost impossible. Numerous instances of it might be cited which would hardly be credited; therefore the moment the coast is seen, the lead only should be trusted to determine the distance from it.

Track from Senegal to Goree.—The *Almadies* of Cape Verde (described hereafter) are 31 leagues S.W. by W. ¼ W. (*S.* 40° *W.*) from the roadstead of the Senegal, and the prevailing currents set nearly on that bearing; it is therefore, the course to be steered from the Senegal to Cape Verde during the day. During the night steer a quarter of a point more westerly. From Cape Verde to Goree the course is direct. It is merely to coast the shore at the distance of 2 miles. From Cape Verde to Cape St. Mary at the mouth of the Gambia, the direct course and distance are S. by E. ¼ E. (*S.E. by S.*) 30½ leagues, in all which space soundings may be found.

Return to Europe.—The voyage from the Senegal to Europe presents no difficulty, and calls for no other precautions than those commonly used in long voyages on seas void of dangers. These precautions are, not to trifle with the wind, but rather to make a good run in a given time, than to endeavour to make good the proposed course. In all return voyages from places within the Tropics, the grand point is to leave the region of the trade wind and get into the variables, and the currents setting to the eastward, as soon as possible. As the winds generally blow from East to N.W. on the coast of Africa, from the month of December to the end of June, you should keep on the starboard tack until out of their influence. The course made good will be about N.W., and you will then be in the neighbourhood of the Azores. It is immaterial whether you pass to the northward or through the channels of these islands, but it has been remarked that the winds are

strongest on the westward. It is seldom possible to pass to the eastward of them. The distance, no doubt, would be shortened; but this passage can be effected only by keeping close to the wind thus far; and experience has proved that, by such procedure, little is to be gained.

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6. DESCRIPTIVE REMARKS AND SAILING DIRECTIONS FOR THE NAVIGATION TO AND OF WESTERN AFRICA.

WITH SOME ACCOUNT OF THE CURRENTS, SEASONS, ETC.; BY CAPTAIN THOMAS MIDGLEY, OF LIVERPOOL, 1837.*

On the Passage from England to the Western Coast of Africa, it may be well to make the island of Madeira and sail to the westward of it if possible; for by so doing the ship will be placed in the best position as to her future course. After passing Madeira, steer so as to leave Palma about 70 or 80 miles to the eastward (if nearer, the ship is liable to be becalmed), and then steer a course to make the N.E. end of Bonavista. Bonavista requires a good berth, as the currents about it are strong and uncertain, and dangers extend from the North and East sides to a great distance from the land.

In the winter, when strong westerly breezes, of long continuance, prevail to the northward, it may be impossible to make Madeira without much trouble and delay; in this case endeavour to get a good observation for longitude, or a sight of the Salvages; and should westerly winds still continue, run boldly to the southward. On nearing the Canary Islands, you will find the wind either gradually decrease to a calm, or it will veer to the northward with heavy squalls. The squalls in this neighbourhood give little warning, but are frequently exceedingly heavy and dangerous. Any ship may very safely run through the passage to the eastward of Palma, as a strong steady N.N.E. or N.E. breeze almost constantly blows through it; and by keeping mid-channel, there is little fear of being becalmed. When clear of the Canaries, a course may be shaped to make Bonavista, as above directed.

The passage between the Islands and Cape Verde is generally and very properly adopted by vessels trading to the Western Coast of Africa; for, by running to the westward of St. Antonio, they have again to make easting in the tract of sea which lying contiguous to the southern limit of the N.E. trade wind, is so often disturbed by calms, squalls, thunder, lightning, and heavy rain.

The currents between the coasts of Great Britain and the Cape Verde Islands are now so well known, that it is almost superfluous to make any further remarks upon them, excepting that their velocity is by no means exaggerated; and the dangerous effect which they have upon vessels, between the Bay of Biscay and the Capes Noon and Bojador, on the African coast,

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* In these remarks, &c., by the late Captain Midgley, as in other parts of this volume, the courses and bearings are by *compass*, unless where otherwise expressed; and every bearing or direction of the current is intended for the *true*.

cannot be too strongly impressed upon the minds of those who have charge of valuable lives and property.

Those *passing Bonavista* in the months of June, July, August, and September, should not be too anxious to make easting; for they will lose the trade wind soon after passing the parallel of the Island of St. Jago, and, after a short interval of calm, fall in with the S.W. wind and its usual accompaniments of heavy squalls and rain. On the further progress, the vessel makes to the southward and eastward, the S.W. winds generally become variable to the westward, and the squalls not so frequent.

At this season of the year it is advisable to give *St. Anne's Shoals* a berth of 50 leagues to the eastward, as the sea sets in so heavily upon the coast, between these shoals and Cape Palmas, that making southing when near the land, in these months, is attended with much difficuly.

From October to April or May, the weather in this tract is generally fine, and the nights cool, beautifully serene and clear, with heavy dews; and in these months a more direct track may be pursued from Bonavista to the southward and eastward, than the one above mentioned. In the influence of the trades, the breeze is generally steady from N.N.E. and N.E., and the sea smooth, occasionally, however, interupted by tornadoes, which, in the neighbourhood of Cape Verga and Sierra Leone, blow with terrible fury. Such is their violence, that it is frequently necessary to keep the ship directly before them, under a foretopmast staysail only.

Between the Cape Verde Islands and the coast, the currents in the above tracks are variable, but mostly found running to the southward, and seldom exceeding 1 mile an hour; generally from half to three-quarters of a mile, until hauling up for St. Anne's Shoals. At about 40 leagues to the westward of these, I have several times found them setting about E.S.E. by chart, fully 1½ mile in the hour.

The sea between the meridian of 20° W. and the bank of soundings extending from the African coast, is perhaps the most luminous part of the Atlantic Ocean. In the very dark gloomy nights of the wet season, with a trong breeze of wind, and when not one solitary star is visible, nothing can exceed, no pen can describe, the awful grandeur and magnificence of the scene. The whole surface of the sea appears as one vast sheet of liquid fire; and the ship, sailing at the rate of 6 or 7 knots through the water, causes streaks of light to be emitted from the sea, that throw a strong yet sickly and appalling glare upon all the sails, creating an indescribable sensation in the mind, that is very far from being agreeable, as the vessel appears to be surrounded by breakers on every side.

Although I have several times noticed this luminous appearance in the same track, I am led to remark more particularly upon it on account of a most awful night which I passed on the 24th of August, 1834, in or about lat. 7° 30′ N. long. 17° 50′ W., which left an impression upon the minds of all on board that I fancy will not be very soon effaced; for the vessel appeared to be sailing through a sea of liquid fire, whilst the heavy dark mass of clouds appeared to rest upon her mastheads, and not a single star was visible amid the horrid gloom. No bottom was found at 120 fathoms. Temperature of the air 82°, and of the water 79° (Fahrenheit).

Vessels in want of Kroumen should call at *Grand Sestros*.—From some years'

experience I can confidently say, that they are the most willing and best disposed men upon the Krou coast; and, if well used, are faithful to their employer in every difficulty he may have to contend with to leeward. Every vessel should take four or five, or more of them, in proportion to her size; for, in the Oil Rivers, if white men are exposed in the boats or canoes, landing or taking in casks, they very soon fall victims to the climate. The Kroumen prefer rice to any other diet, and a good supply can generally be procured at a cheap rate, except between January and June; but, considering the detention of lying-to, in order to procure it, the rice may be exported from England, for ships' use, at very nearly as cheap a rate. One of the Kroumen is of more real service in the Oil Rivers than two Europeans; they are generally well versed in the English language; and are contented with a dash or present when left at Fernando Po, after the vessel has completed her lading.

On approaching the Krou coast it is usual to hoist the ensign and fire a gun, and the vessel will be soon surrounded by canoes. A small canoe may be purchased for the ship's use for a mere trifle, and will be found extremely serviceable in the rivers.

The navigation between Cape Lahou and the land of Formosa presents no difficulty to the navigator; the currents in the route run to the eastward at 1, 1½, and sometimes 2 knots or more, in the hour. If there be no inducement to call at Bereby, Drewin, or Cape Lahou, for ivory, it will be as well (and will certainly expedite the passage) to shape a course from Cape Palmas for Cape Three Points; and then, giving that land a berth of 5 or 6 leagues, shape a course for the land of Formosa.

In steering across the Bight of Benin, the current will be generally found running about 1 mile an hour to the N.E.; and must be allowed for by steering one-third of a point to the southward of the direct course.

A mere inspection of the chart will show that what is erroneously called Cape Formosa is, in fact, an elbow land rounding off gradually to the eastward; and regular soundings upon a muddy bottom extend for some considerable distance to the westward and southward of it. The land is here extremely low, and should not be approached in the night nearer than in 8 or 10 fathoms, unless by a vessel prepared to anchor.

After making the land, the oldest and most experienced traders to the Oil Rivers are frequently deceived as to the position of the vessels; for the best description of the rivers from Formosa to Bonny is but vague and imperfect; and I therefore proceed to give such directions as I think, from my own experience, will be found useful to vessels bound to the Bonny or New Calabar Rivers.

The rivers between Terra Formosa and Bonny have all shoal bars at the entrance, and generally appear from the offing to be narrow. They have no peculiar feature to distinguish them, other than their being open to such points of the compass as are expressed in the Sailing Directions.

The Seasons here appear to have been imperfectly described. The rains generally commence in the latter end of May, or early in June, and gradually increase, with strong S.S.W. and S.W. breezes, during the months of July, August, and great part of September, towards the end of which month they as gradually terminate. In July and August heavy squalls frequently

prevail; and in these months the wind very rarely shifts more than between S.S.W. and S.W., and the rain is incessant from sunset to nearly noon next day, when it ceases for a few hours, and again commences with more or less violence in the evening. In October the weather becomes more settled, with light land winds, and occasionally showers of rain, which, however, yield to the moderate sea breeze that sets in about 10 or 11 a.m. In November the tornadoes commence, and are at first violent, gradually decreasing in strength as the *Harmattan* or *dry season* commences, although they are occasionally prevalent from this month to May. In December, January, and February, is the Harmattan season; and in these months the sea breeze sets in about noon, and blows with very moderate force from the W.S.W. and westward until sunset, when it dies away to a calm. During the night there is little or no wind, and the weather is extremely sultry and oppressive, and very heavy and unwholesome dews. After daylight a light air springs up from the northward or N.N.E., which gradually increases to a moderate force, and continues until about 11 a.m., when it falls calm, and soon after is succeeded by the light westerly breeze. The Harmattan, however, sometimes blows steadily and without intermission from the N.E. quarter for several days together, especially about the new and full moon. It is at this season that the *smokes* prevail, and are exceedingly injurious to the European constitution. These smokes are so dense that it is impossible to see a cable's length from the ship for days together; and any vessels that may be in the offing, inward bound, have no resource but to anchor, and wait with patience for clearer weather. In March, April, and May, the weather is clear, with light land winds at day-break, which gradually die away, are succeeded by the W.S.W. breeze about 10 a.m.; and this breeze blows with moderate force during the remainder of the day and greater part of the night. In these months the atmosphere is serene and clear, particularly during the nights, which are very fine indeed. The palm oil season commences in the early part of March; the oil becomes plentiful in April, and continues to be so until September, when it declines; and from October till March it is, properly speaking, out of season, although small quantities of it may be procured in these months.

In the foregoing remarks as to the season and climate, I beg to be understood as speaking of the New Calabar and Bonny Rivers only, and now proceed to consider the best means of preserving the health of the crews of vessels trading there. Masters of vessels should be on their guard against shipping plethoric or lusty men to go to the Oil Rivers of Africa. Drunkards are still worse subjects than these; for if a man undermines his constitution by intemperance in England, he cannot repair it in Africa. I have too frequently remarked that human skill is of little avail in saving the life of a drunkard when once attacked with the African fever. The fact is, a drunkard is predisposed to sickness, and soon falls a victim to the climate. The plethoric or lusty man, if he has not tampered with his constitution, has a rather better chance; but should he fortunately recover from the fever, he is often annoyed with attacks of ague all the passage home, and does not recover until he arrives in England. Thin, raw-boned subjects are the best for the coast of Africa; and they should be selected from men who have made several voyages to the West Indies, as they are, in some degree,

seasoned to a warm climate; and those that have never made voyages to tropical climates should be decidedly rejected. To preserve the health of the crew, the vessel should be housed over as soon as possible after her arrival in the river. Plenty of mats should be procured, and a good, substantial, tight house be at once made, to shelter the crew, and preserve the vessel from the weather. Every care should be taken to make the house perfectly water-tight, as well for the comfort and health of the seamen, as for the advantage of working the palm oil in wet weather. An overstrained economy in the purchase of a few mats is highly reprehensible. The seamen will generally hang hammocks under the house; and, if well sheltered from the weather, will enjoy better health than they would by sleeping below in the steam emitted from the oil. In these rivers it is presumed that the Kroumen do all out-duty required in the boats, &c.; for a European should not be allowed to put his foot over the side, either for the purpose of visiting or going ashore, even on ship's duty (unless unavoidable), as it infallibly leads to dissension and drunkenness from the worst of spirits; and a drunken fit in Africa is the almost sure forerunner of sickness, and probably death.

All vessels should keep a sufficient quantity of English water on board for use in the country, as the Bonny and New Calabar water has an immense quantity of animalculæ, is very unpleasant to the palate, and injurious to health. Cocoa is an excellent and nutritious article of diet; and the crew should be well supplied with yams, which are the only vegetable, excepting corn and plaintains (the latter not plentiful), that can be procured in these rivers.

If the crew unavoidably get wet, they should immediately rub themselves thoroughly dry with coarse cloths, and put on dry clothes. The forecastle should be frequently cleaned out with a solution of chloride of lime, and the seamen's clothes and bedding kept well aired. Attending to these precautions will be found the best means of preserving health.

Here I may observe that fresh stock of all kinds is very scarce and very dear in these rivers, so that vessels bound to Bonny or New Calabar would do well by procuring their fresh stock and corn to windward, either on the Krou Coast, Frisco, Cape Lahou, the various settlements on the Gold Coast, or at a small village on the sea coast, near Cape St. Paul, called Dokko, or Occo. At these places stock of all kinds is abundant, and very cheap when obtained in barter.

Current.—I have almost omitted putting the mariner on his guard against the effect of the strong easterly current that runs from Terra Formosa to Old Calabar. This current runs with greater or less velocity almost throughout the year, except in or about the Harmattan season, when it occasionally sets to the westward and W.S.W. Vessels that have advanced much to the eastward of Terra Formosa, and cannot see Foché Point before night, should anchor, in order to prevent the effect of the current; but in squally weather, or the wet season, it may be as well to work to windward, heaving to occasionally during the night, according to circumstances; 9 or 10 fathoms is quite close enough to stand in-shore in the night; when in 6 fathoms the surf can be very distinctly heard.

When once to leeward on this coast, getting up to windward again is attended with much trouble and difficulty. I may here remark, that too

much attention cannot be paid to the lead upon any part of the coast of Africa, as the current frequently sets directly in upon the land; and from careful observation, upon the windward coast, I can confidently assert that the thermometer is no guide whatever on approaching the land. In more than 100 experiments upon the *surface* water, I could never detect any sensible difference in the temperature when sailing toward the land from no bottom into 45 and 40 fathoms, and then into 14 or 15 fathoms, on the Krou Coast. In the dry season there is little difference hereabout in the temperature of the air and water; the former averaging 77° to 81° (in the shade), and the latter 74° or 75° Fahrenheit.

Directions.—*The Homeward Passage*, through the Bight of Biafra, presents no particular feature to the attention of the navigator, if I may except the strong N.E. currents that almost invariably prevail in it. All homeward bound vessels that do not intend calling at Fernando Po, should use every possible exertion to pass to the westward of the island, as a good board may be then made to the southward on the starboard tack. Except in the Harmattan or tornado seasons, no advantage can be derived by standing close in-shore, as there are no land winds, and a near approach is, at any time, very dangerous, as the whole of the coast, from Camaroens to the Gaboon (except about Corisco), is generally bold-to, and the soundings in nowise to be depended on. On this part of the coast there is no trade, and the inhabitants are miserable naked savages. On getting to the southward of Prince's Island, the very excellent directions of Mr. Finlaison (given hereafter) may be followed with advantage.

Many navigators have remarked, that on standing to the westward between Prince's and St. Thomas's, even when making a trifle of northing, the N.E. current has been found to diminish in strength as the vessel makes westing. Even so far to the southward as 3° South there is seldom any easting in the wind before passing the meridian of Greenwich.

Vessels bound to the northward should not attempt crossing the equator to the eastward of 20° W. (the meridian of 21½° W. is to be preferred), and should then make a North or N. by W. course, to get into the N.E. trade wind, which having once fairly gained, the homeward navigation is generally well understood. In this route, after leaving the *Guinea Current* in the Bight of Biafra, the ship will gradually get into the *Equatorial Current* as she gets to the southward, and this current frequently runs with considerable velocity. On examining my journals, I find that, by good lunar observations and an excellent chronometer, I have, at various times, made the following differences to the *westward* of dead reckoning, in the run from St. Thomas's to longitude 20° West of Greenwich, between the parallels of 0° 35′ North, and 3° of *South* latitude. In April, 1830, the brig *Anne* was set 237 miles to the westward and 78 miles to the northward of account in 20 days. In October and November, 1831, the barque *Severn* was set 240 miles to the westward, and 94 to the northward of account in 23 days. In October, 1833, the *Freeland* was set 146 miles to the westward, and 51 to the northward of account, in 20 days. In August, 1835, the same vessel was set 228 miles to the westward, and 43 to the northward in 19 days; and in November and December, 1836, the *Caledonia* was set 373 miles to the westward and 107 miles to the northward in 18 days. But it may be observed that, in the

latter vessel, I never crossed the equator, but was generally 8 or 10 miles to the northward of it, until I crossed the meridian of 12° W. In the above runs I have occasionally, but rarely, found slight differences to the southward. When to the southward of the equator, abreast of the Bight of Benin, I have always found a current running at least three-quarters of a mile an hour to the northward.

By Commander W. B. Oliver, R.N.

Conceiving that a shorter passage by a sailing ship from the Bights, or Prince's Island to Sierra Leone, than that made by proceeding to the southward of the Line, might be made by keeping to the northward, I determined to ascertain the fact; and though each time accompanied and retarded by a prize, made three unusually short passages, viz.—one from the River Bonny, anchoring at Prince's, and landing prisoners at St. Thomas's in eighteen days, the other two in 13 days each from Prince's Island to Sierra Leone; and, on returning to England in H.M. schooner, unaccompanied by a prize. Thirty-nine days having been the shortest of three prizes I sent up under the old directions from Benin and the Gaboon. I issued different directions to prize-masters; and, although not acted on, in absence from myself, I feel assured they would have proved, as they did in my company, an improvement on the old one; a copy of which directions are as follows:—

Your first object will be to get to the southward, unless you can make a West course (*true*) without any northing; nor should you go to the port tack unless you can do so, or to avoid the land, Should the wind hang so much to the westward as to prevent making a good course on the port tack, pass to the eastward of Prince's or St. Thomas, or both, as you will sooner get out of the strong easterly current, but do not approach the land within 20 fathoms, day or night, and get frequent casts of the lead.

When to the westward of St. Thomas, and on or near the Line, steer W. ½ N., or W. by N., according as your noon sights give you a northerly set or not, until in the longitude of Cape Palmas, 7° 45′ W.; when steer, in the rainy season (May to September), N.W. by N.; in the other months, N.W., until in 13° W., the longitude of the western limit of the St. Anne Shoals; you may then make a true North course, sounding every 5 miles by night, or thick weather, and every 10 miles by day, from 6° N. to 8° N. If you reach the latter without striking soundings, it will prove that you have passed to the westward of the Anne Shoals; when keep away E. by N., by compass, to 8° 15′ N.; then steer E. by S. ¾ S. (*East, true*), and you will make the high land of Sierra Leone; if by night, anchor on reaching 12 fathoms.

These instructions can only be acted on in a general way, as of course much depends on winds and currents; but I wish them to have full weight with any officer detached in a prize; and remember, the land about Sierra Leone should always be made to the southward of the cape.

7.—OF SHIPS BOUND TO AND FROM THE WEST INDIES, WITH INSTRUCTIONS FOR NAVIGATING THEREIN.

The courses of these ships are regulated by the winds and currents which have been described in the preceding chapters. The consequence is a circuitous track, requisite to be taken, not only to the West Indies, but to the southern parts of the United States. For having passed Cape Finisterre, as before described, the best course is then to the S.S.W., so as to gain the trade winds quickly. The preceding observations on passing Madeira, &c., may, therefore, in this instance, be useful, as well as in the former.

As the great object is to attain the N.E. trade, in order to run down your westing with as little delay as possible, the remarks upon the passage across the Equator will almost apply equally to this voyage; the more especially those given by Capt. Maury as to a *westerly* track from the channel leading through steadier winds, and therefore more particularly applicable to the route across the Atlantic in the Trades, where there is no object in maintaining an easterly position to avoid being driven to leeward of the Brasilian coast.

In confirmation of this view, Captain George Cheveley, of Liverpool, remarks, that he would recommend to ships clearing the English Channel, *if bound for the West Indies*, to make the S.W. quadrant, *true*, so as to pass nearly at an equal distance between Madeira and St. Mary's Captain Clevely adds, that, by pursuing this track, he has invariably held a steadier breeze, and got much quicker into the Trades than when he proceeded further to the eastward, and so endeavoured to make more southing. He is aware that the latter is the *general practice*, of which he entirely disapproves, so far as concerns a West India passage.

Ships for Jamaica generally pass to the southward of the Island Montserrat, and thence proceed for the high rock called Alta Vela, off the southern point of St. Domingo, whence they take a departure for the eastern end of Jamaica. When homeward bound, they pass either through the Windward Channel or the Strait of Florida, as the wind and other circumstances may prevail or dictate.

Between the months of October and March, northerly winds prevail over the Mexican Sea and the adjacent regions; and when northerly winds prevail in the Strait of Florida, the Windward Channel must, of course, be preferred; but, at all other times—at least, generally at other times—the quickest, and, therefore, most eligible, passage is through the Channel of Yucatan, and thence, with the Florida Stream in your favour, through the Strait of Florida.

Although the Windward Channel appears, by the chart, to be the shorter and readier passage, yet ships are frequently opposed here, both by wind and current, as will appear by the following statement, made by an ingenious officer already quoted:—"After the defeat of the French fleet, commanded by Count de Grasse, in April, 1782, and the British had arrived at Port Royal, in Jamaica, a squadron was detached to gain the Windward Passage, run down the Bahama Old Channel, and cruise to the eastward of the Havana, to prevent a Spanish squadron, in the harbour, from effecting a

junction with the French ships that had escaped into Cape François [*Cape Haytien*]. For six weeks did the English squadron beat against fresh sea breezes and a lee current; and, during that time, never advanced further to the eastward than off Morant Harbour, though the ships were much strained by carrying a press of sail to attain their object; but, after struggling so long, were compelled to return, baffled, into port. Now, though the first object might have been to meet the Spanish squadron on its way to Cape François [*Haytien*], if it had sailed, yet, so soon as the effect of a lee current was ascertained, the object of gaining the Windward Passage ought to have been immediately abandoned, when, by bearing away with a favourable current for some distance, and before a fresh trade wind, Cape Antonio might have been passed the second day, the squadron have been off the Dry Tortugas on the third, and by beating along the Florida shore with a weather current, when to the eastward of the meridian of Havana, it could have stretched over to Cuba in the night; and, in all probability, have gained the appointed station in six days, or even, perhaps, as soon as it could have gained Cape Maysi, if the easterly wind had been moderate, and no current to contend with."*

When the trade wind blows strong, and in frequent squalls, during the summer months, between Jamaica and Hayti, and a short turbulent sea is found eastward of the former, then will those bound for Europe or the United States shorten the period of their voyage by bearing away for the West end of Cuba, and passing through the Strait of Florida. For the strait presents a more eligible navigation in these months than the Windward Channel. The sea breeze will ensure a quick run to the Channel of Yucatan; and the current, perpetually setting eastward between Cuba and Florida, will, in a few days, carry any vessel into the strait, where it will be nearly impossible to remain much above two days, in the strength of the stream, after being on the parallel of the Bemini Islands, even if there were not a breath of wind.

But as the North winds prevail in the Strait of Florida in October, and

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* "I think that this paragraph, unless qualified, is calculated to mislead; particularly in the words, 'when, by bearing away with a favourable current for some distance, and before a fresh trade wind, Cape Antonio might have been passed on the second day.' Admitting the general experience of the writer of this passage, I think he states an extreme case. The distance from Port Royal to Cape Antonio is 518 miles; which (divided by 48) equals more than 10½ miles per hour. Generally, there would be nothing extraordinary in this performance, but I much doubt if it be often accomplished in the locality alluded to, at the time of the year supposed; viz., in the middle of May. In that month of 1833, I was ordered from Montego Bay to New Providence; at the former place I consulted some of the most experienced commanders of West Indiamen, whether the most eligible course would be that of Cape Maysi or Cape Antonio; the majority recommended the latter, and I more readily deferred to their advice, from its concurrence with that contained in the extract, the previous consideration of which had occupied my mind.

"Finally, although the advice contained in the extract above is judicious in establishing the advantages of the Leeward Passage, I repeat, that the hopes of making it so speedily as is represented will not often be realised, for neither very favourable currents, nor fresh trade winds, will be experienced upon that track at the season indicated; nevertheless, there is the all-important distinction between the passages of *certainty* and *uncertainty*."—*Lieutenant W. H. Brady, R.N.*

frequently during winter, when variable winds and strong land breezes are not common on the coast of Jamaica, shipping will find this the most favourable period for gaining the Windward Channel. In January or February, if the wind offers a favourable opportunity for gaining the East end of Cuba, this track should be taken; but if the sea breeze be strong, the Strait of Florida should be preferred.*

When the sun has approached the Tropic of Cancer, strong westerly winds begin to blow along the western coast of Florida, and prevail during the months of June, July, and August, from the Bay of Apalaché, southward. These westerly winds cause fluctuations in the atmosphere, which prevail more about the western end of Cuba than farther eastward; and near the Havana they have little influence. At this season, vessels from Jamaica have met a westerly wind in the Channel of Yucatan; others have experienced a fair breeze at some distance, after passing Cape Antonio; and the wind here will be found sometimes at N.W., West, and S.W., veering about variably.

The wind in the eastern quarter sometimes fluctuates about the western end of Cuba, but not generally.

At this season the wind blows impetuously off Jamaica, and in frequent squalls; and vessels bound thence to Europe should universally prefer the Leeward Passage. They will probably pass through the Strait of Florida before they could gain the entrance of the Windward Channel, though straining, with every effort, against the wind. The *appearance* of a favourable opportunity for passing through that channel should not be suffered to deceive; for it may be no indication of the general state of the wind eastward.

From the West Indies to the English Channel, after having cleared the Strait of Florida or Windward Passages, vessels may pass either to the northward or southward of the Bermudas, giving the islands a good offing, and attending to the preceding remarks on currents, &c. In summer, the track to the northward of these isles has been recommended, passing thence to the northward of the Azores. In winter, the track to the southward of the Bermudas is to be preferred; because, in this season, gales of northwesterly wind may be expected from the coast of America; and, therefore, vessels should continue a little to the southward of lat. 30° or in about lat. 29° 40′, if wind permits, until certain of being to the eastward of the Bermudas; nor should they run to the northward of lat. 35° or lat. 36°, until within a few degrees of the Azores. Thus will the heavy gales be avoided, which frequently rage more to the northward.†

In shaping a course at any season, it should be remembered that the Great circle course from Cape Florida to the Lizard follows the outer edge

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* In sailing for the Windward Channel, get the coast of Hayti on board as soon as you can, as you may then find a windward current, and, in the evening, the wind off shore.

† As the most destructive hurricanes on record, in this part of the Atlantic, have occurred in the vicinity or on the borders of the Gulf Stream, this is an important reason for ships from the West Indies, bound to Europe, not to advance too far to the northward. See further, "Voyage from the West Indies to the Azores," attached to the description of those islands hereafter.

of the Gulf Stream in its earlier course, and passing about midway between the Bermudas and Cape Hatteras, it bears away north-eastward over the tail of the Newfoundland Banks, and reaches the parallel of Scilly on a due easterly course. The vertex of the Great Circle being in lat. 50° and long. 13° 48′ W., of course its direction is nearly East and West for several degrees on either side of this point. The shortest distance between the Lizard and Cape Florida is 3,671 miles. It leaves the Strait of Florida on a nearly due N.E. course *true* (N. 45° 35′ E.), and reaches the channel on an E. ½ S. true course.

During a great portion of the year, it is probable that this course could be strictly followed to advantage. Of course, the consideration of meeting with cyclones which follow very nearly this Great Circle course toward the N.E. is important, and therefore during their season, July to October, as shown in (112), on p. 264, a more easterly route had better be pursued, that is, if the Florida Channel be taken; but if, as is more probable, the windward passage is taken in this season, the Great Circle course thence will be the most advantageous.

But upon this subject Major Rennell has said, "Notwithstanding the advantages to be gained, in point of distance, by ships returning from the West Indies by the favouring current of the *Gulf Stream*, which may be perhaps reckoned equal to several days' sailing; yet experienced navigators are still of opinion that, on the whole, it does not present equal advantages with the southern route.

"It was, until latter times, held as a maxim not to advance to the northward of the parallel of lat. 33°, in returninge from the West Indies, because of the prevalence of storms northward of it. This wise rule of our ancestors has again been taken up, and His Majesty's ships, and of course convoys, will be, in future, directed to proceed by the South of Bermudas, and to cross its parallel at a few degrees to the eastward of the isles, and thence to steer direct for Corvo.

"But, it may be observed, that a track which should cross the parallel of Bermudas at a *very few* degrees to the eastward of it, and then lead directly toward Corvo, would cross a most critical portion of the space, in which not only the warm water of the Gulf Stream prevailed, but in which several gales have been actually experienced. Therefore, it would seem that the parallel of the Bermudas should not be crossed at less than about lat. 15° [say lat. 14°] to the eastward of the islands.

"But, it may be asked, Where is the necessity of going to Corvo or Flores at all, for by it ships are placed in a situation proverbially known as a place of storms; that is to say, on the West and N.W. of the Azores? Why not go between *them* and the *greater Azores*, or rather to the southward of them all, and thereby pass through a kindlier climate at all times?

"Any calculations or comparisons of time in making the different passages would be nugatory, since the security of lives and property is the main object; but it even happens that ships, which have had all the advantage of the Gulf Stream, have been crippled, and made more delay than in the southern passage with adverse currents."

Directions for Sailing to and from the West Indies and North America, translated from the "Derrotero de las Antillas," by Captain Livingston.

These advices, or directions, are simple applications of a principle derived from the general prevalence of the winds, as already described.

Were it not for the constant wind from the eastward, which reigns within the tropics, it seems likely that the maritime commerce between the two hemispheres would never have existed; for, by its means, not only are the voyages rendered very simple, which would otherwise be interminable, but people in the most distant regions communicate with facility; and thus the navigator who is bound to the westward has only to place himself within the limits of the general wind, in the certainty that, in this manner, he must effect his purpose in the shortest possible period. Such is the *first* rule, which ought always to be attended to for this navigation.

The *second rule* is derived from the first; it is, that any one, bound to the East from the West, ought to get out of the region of the trade-winds into that of the variables or anti-trades.

We have here the two precepts which direct the operation of navigators in extensive seas; and in attending to them we shall observe, that every one bound from the Peninsula (Spain and Portugal) to the eastern coasts of America, ought to get into the trade-winds as soon as may be, holding in mind an advice, which may be considered as a precept, that is, *never, in navigating extensive seas, to keep close-hauled, but always take care to sail with the wind free; or at least to keep seven points from it.*

Taking it as granted that the first care of every one bound to America ought to be to get into the limits of the general wind, it is clear that, with scant winds, the tack in the third quadrant (S.W.) will be most advantageous, and ought to be followed always when it can. All the endeavour ought to be to get into these winds, without being particular as to the means, and without keeping close to the wind to pass between the coast of Africa and the Canaries; but taking the passage that suits best, be it that between the Canaries and Madeira, or be it between Madeira and the Azores; and certainly either of these is preferable to that to the East of the Canaries; for the proximity of the coast of Africa deadens the wind, and, consequently, is unfavourable to the brevity of the navigation.

Having gained the general winds, the navigator must take precautions conducing to prevent any error of situation, in making his port of destination; for, if he who navigates by observations is exposed to be even 10 leagues in error, he who has no more than dead-reckoning to direct him may, probably, be 6 degrees wrong. It imports much to guard against this error; keeping it in view that, in proportion as it will be easy for any one, making a landfall to windward of his port of destination, to run down to it; so will be the difficulty if he makes the landfall to leeward of his port, in beating up again in a sea wherein both the winds and currents are contrary. Even if bound to the coasts of the United States of America, it will be advisable to run into the limits of the trade-winds, in order to get to the westward in as short a time as possible; and although this mode may

appear long, on account of having again, after crossing to augment the latitude, it will be sufficient to keep in view the following maxim, to convince any one of the contrary:—*If in the one way the distance is shorter, in the other the velocity with which the ship proceeds towards her port of destination more than balances it.*

There are, nevertheless, many occasions on which a vessel may run across to the American coast without reducing her latitude, and these occasions may be frequent in the forty or fifty days which follow the two equinoxes, as epochs during which the N.E. winds generally prevail; therefore vessels which, at these times, make their passages, may at once follow their voyage in high parallels, without descending to low ones.

In summer, as the region of the general or trade-winds extends to about lat. 28° 30′ N., it follows that the round about is trifling; and this circumstance ought to be attended to in the calculations which every captain of a ship should make before he fixes on the course he will pursue.

Recapitulating what we have said about the course which is most advisable for crossing to the United States, from the coasts of Spain, it follows that, if the winds permit it, West is the preferable course; and, in case the winds will not allow of shaping that course, the most advisable track will be that which comes nearest to it, if the voyage is made at the times above mentioned after the equinoxes; but if at any other time, a course in the third quadrant (S.W.) should be preferred; for this will carry the vessel soonest into the general winds, with which the necessary longitude may be shortly gained.

Vessels bound to Cuba during the rainy season, or season of the South winds, should pass to the northward of Porto Rico and Hayti; but during the Norths they ought to go to the southward of these islands. The ports chiefly frequented are, St. Iago on the South, and Havana on the N.W. If bound to the first, it is necessary, in whatever season, to proceed directly to it, that is, in the season of the Norths, to steer from Cape Tiburon, to make some point on the South of Cuba to windward of the intended port, or even to windward of Guantanamo; and in the season of the Souths, to steer from the Point of Mole St. Nicholas almost West for the port, marking, in the first instance, various points on the coast of Cuba.

If bound to Havana, in the time of the Norths, you should pass to the southward of Cuba, although you will have to return the distance, between Cape Antonio and Havana; because this inconvenience is not comparable to that which might be occasioned on the North side of the island by a hard *North*, which would not only expose a vessel to heavy risks, but might protract the voyage much longer than the course above described, because the distance in the latter case may be worked up in a short time.

From St. Iago de Cuba, as the coast is clear, a vessel for Europe may easily make her way by the Windward Passages, while all those which are bound from Havana will take the Strait of Florida. The risks in the latter emanated from bad charts and ignorance of the currents; the charts are now rectified, and the current is known.

By the *Strait of Florida* we understand the space included between the meridian of the Dry Tortugas and the parallel of Cape Cañaveral. The simple inspection of the chart will show this to be a bed or course, which,

like a river, conducts the water to the northward. This river, or general current, flows first to the E.N.E. as far as the western meridian of the Double Shot Kays, by which Kays the stream is divided from E.N.E. to N. by E., the direction which it pursues on the parallel of Cape Florida; thence to Cape Cañaveral it runs North, with something of an inclination to the East.

As it is undoubted that this general current is caused by a superabundance of waters, which seek, by this drain, to regain their level in the open ocean, it follows that its rapidity will be greater or less, according to the said superabundance of waters; but as a change cannot be momentary, on account of the great reservoir in which the water is contained, but progressive, and of course slow, we hold that, having once ascertained the velocity of the current, we may calculate it for three days or more in advance without much error, if the wind remains in the same direction; for an alteration in the wind may affect the force of the current considerably, as already explained.

On the meridian of the Havana stripes of current are, at times, found setting to the E.S.E. and S.E. from the Tortugas Soundings. Care should be taken not to confuse the southern differences, caused by this branch of the current, with those caused by the eddy current near the Colorados—the one giving eastern departure, the other West. The distinction is very clear, and can admit of no doubt, because the eddy current is met only from the meridians of Cavanas and Bahia Honda to Cape Antonio, and not farther out from the coast than the parallel of 23°

As the velocity of the current varies, it is requisite for every navigator to ascertain its strength as frequently as possible, while within the stream. Every one who enters this channel, having marked well either the lands of Cuba or the Florida Reef, so as accurately to establish this point of departure, ought to determine, in his *first day's* work, the velocity of the current by the difference of latitude by account and observation. We say during the first day's work, because the generality of common navigators make use of meridian altitudes of the sun alone to find the latitude; but it is very clear that *altitudes of the planets and fixed stars ought not to be neglected; not only because by this you cannot be in doubt of your real latitude, but also, because they may be more exact than latitudes deduced from meridional altitudes of the sun, when that luminary passes in the proximity of the zenith, and because these repeated observations during the night assure, as much as possible, the situation of the ship.* Thus you may go on, with a clear idea of the operation of the current, and the way that the ship is making. Having ascertained the velocity of the current, use can be made of it to find the ship's departure, and this knowledge will be most important when you fail in obtaining observations for latitude; because, in such a case, wanting a knowledge of the difference of latitude given by the current, you will be in want of everything; but if you know the velocity of the current, with it and the course which it follows, you may find the difference of latitude and departure which the current gives; and which, though it will not give the position of the ship with that precision with which it might be obtained by latitude observed, will still approximate sufficiently to the truth to enable one to avoid danger, if prudence and seamanlike conduct are combined.

For those who have little experience in the navigation of these seas, we add:—

1.—That it is most convenient to direct your course in mid-channel; not only because it is the furthest from danger, but because you will there have the strongest current, which is desirable.

2.—That, as you cannot ascertain, with all necessary certainty, the position of the ship, notwithstanding the rules given to diminish the errors occasioned by the currents, you ought, with the utmost care, to shun the eastern coast of Florida, as being very dangerous, the trade-wind blowing upon it; while there is not be least risk in running along the Salt Kay Bank, and the edge of the Great Bank of Bahama. Upon the latter, also, you meet with good anchorages, very fit to lie in during the hard northerly gales experienced between November and March, and which do not fail to cause many damages, and sometimes even force vessels to bear away, which is always dangerous, for the weather is always thick with such winds, and the worst case will be to run into one of them upon the coast of Cuba, when hoping to have made Havana or Mantanzas. Hence, therefore, as soon as there is an appearance of a North, the best way is, if near the Salt Kay Bank, to anchor on it; and, if near the Great Bank, to approach the edge of it, in order to be able to anchor when it may be necessary; for although you may have a hard *North*, so long as you can lie-to in it, you ought to pursue your navigation, as the current will certainly carry the ship through the strait.

3.—It is very necessary to sight the Kays on the Salt Kay Bank, even though you have no fear of a *North;* and there may be occasions in which every exertion should be made to make them; especially if, from want of observations, the situation of the ship is not well known.

4.—When, owing to calms or light winds, a vessels is in danger of being carried through the strait by the current, she ought immediately to approach the edge of the Salt Kay Bank, or of the Great Bank, to descend from it to the coast of Cuba, without trying to beat down the lost ground; for, by doing this, she would only render the being carried through more certain.

5.—Should you involuntarily approach the coast of Florida, you should take extraordinary care to examine whether you have advanced out of the general current and into the eddy. That you may know this, observe, the eddy forms a remarkable and visible line between it and the general current, which line of division is, in many places, out of sight of land; that, in general, you have no soundings on it; and that it shows, not only by the change in the colour of the water, but that also in it, during the greatest calms, there is a kind of boiling or overflowing of the water. From this line of division the water gradually changes colour; so that, near the Florida Kays, it is of a beautiful sea-green, and at last it becomes almost as white as milk.

6.—When in the eddy you have to make the correction of currents on courses entirely different from those in the stream. This is the more necessary to be remarked, because, from ignorance of this circumstance, several have been shipwrecked.

7.—When you enter the channel, or strait, from the Tortugas Soundings,

with the intention of passing through, take care to become certain of the land of Cuba, or some part of the Reef of Florida, in order to have a good point of departure; for, although the latitudes and soundings on the Tortugas Bank are more than sufficient to ascertain the place of the ship, yet the variable set of the current toward the Havana may produce a serious error, if not properly attended to. The meridian of the Havana is, in a word, the best point of departure for ships bound to the north-eastward.

On Proceeding to the Windward or Caribbee Islands.

As to choosing the North or South part of any of these isles for making your landfall, you ought to consider, *first*, which point is nearest to the port or road to which you are destined; and, *secondly*, the season in which you go. In the dry season, it is to be remembered that the winds are generally from the north-eastward, and in the rainy season they are often from the south-eastward. Thus, in the dry season, it is best to make the North side, and in the wet season the South, but without loosing sight of the first consideration.

There can be no mistake in recognising any of the Antillas; nor, in making *St. Bartholomew's* and *St. Martin's* alone, can there be any doubt on seeing at once the eminences or heights of various islands. That this may not mislead any one, they must remember the following instructions:—

When in the parallel of St. Bartholomew's, at less than 4 leagues off, if there be no fog or haze, the Islands of St. Eustatius, Saba, St. Christopher's Nevis, and St. Martin's, appear plainly.

The mountain of *St. Eustatius* forms a kind of table, with uniform declivities to the East and West; the top is level, and at the East part of this plain a peak rises, which makes it very remarkable. To the West of the mountain seems to be a great strait, in consequence of the lands near it being under the horizon (or seeming drowned), and to the West of that there then appears, as it were, another long, low island, the N.W. part of which is highest; but it is necessary not to be deceived, for all that land is part of the land of St. Eustatius. From this station Saba appears to the N.W.; it is not so high as St. Eustatius, and apparently of less extent than the western part of St. Eustatius, which is seen insulated.

The N.W. part of St. Christopher's is also seen formed by great mountains, in appearance as elevated as St. Eustatius, with low land to the East; to the eastward of this low land *Nevis* will be seen apparently higher than all the others.

The lands of *St. Martin's* are notably higher than those of St. Bartholomew's; and this island appears also when you are some leagues further from it than from St. Bartholomew's.

When there are any clouds which hinder St. Martin's from being seen, there may be some hesitation in recognising *St. Bartholomew's*; and thus it is proper to notice that the latter, seen upon its own parallel, appears small, and with four peaks, trending North and South, occupying almost its whole

extent; and, if you are not more than 8 leagues from it, you will see, also, the appearance of an islet to the North, and another to the South, at a very short distance. As this island, has neither trees, high mountains, nor thickets, it is not subject to fogs; and it may therefore be seen oftener than St. Martin's, St. Christopher's, Nevis, St. Eustatius, and Saba; it is therefore advisable to keep its appearance in mind.

At 8 leagues to the East of St. Bartholomew's you may see *Nevis*, very high; from it to the West the strait called the Narrows, and then the lands of *St. Christopher's*, appearing to rise out of the water, and which continue increasing in height to the westward, so that the western-most of two mountains, which are at the West part of it, is the highest. This mountain, which is higher than that called *Mount Misery*, has to the West of it, a gentle declivity, terminating in low land; and it cannot be mistaken for any other. To the West of this you may also see the large strait toward *St. Eustatius;* but from this situation you will see only the high S.E. part of that island, or rather, its mountain, in consequence of which it appears like a very small island, while its mountain seems to be lower than Mount Misery; but it is easily known by the *table*, which its top forms, by the uniform declivities to the East and West, and by the peak on the S.E. part of it. *Saba* seems, from this situation, equal in size to the visible part of St. Eustatius; but it shows only an eminence without peaks, with declivities, and almost round.

If a small islet appears to the West of, and very near to St. Eustatius, that must not confuse you; for it is the N.W. extremity of that island; and, on getting nearer, you will perceive the land which connects it with the S.E. part. *Mount Misery*, on St. Christopher's, which has a very high and sharp peak, on the eastern part of its summit, seems at a distance to be the summit of Mount Eustatius; but it cannot be mistaken for such, if you attend to its surface being more unequal than the table land at the top of St. Eustatius; and that there is another less elevated mountain to the East, and with gentle declivities, which show much land to the East and West of the high peak.

When you are 6 leagues to the East of St. Bartholomew's, its N.W. extremity appears insulated, and has the appearance of a pretty large island, on the top of which there are four small steps (like steps of stairs, *Escalones*), with a considerable strait to the South, between it and the principal island: in the middle of this strait you may also see a smaller islet; this is really one of the islets which surround the island; but the first is only the N.W. point, to the North of which you will see some islets: all these are much nearer St. Bartholomew's than St. Martin's.

Finally, in navigating from one of the Antillas to another, there is no difficulty, unless you have to get from leeward to windward; yet this will be reduced to a trifling consideration if the passage be made by the straits to the northward of Martinique, in which the currents are weakest; but the same does not follow in the southerly straits, in which the waters set with more vivacity toward the West: and it would be impracticable by the Straits of Tobago, Granada, and St. Vincent, in which the waters commonly run at the rate of not less than 2 miles an hour.

Particular Instructions for the Navigation of the Windward Islands, &c.

It has been remarked, by an experienced captain in the Royal Navy, that for *those bound to Jamaica or any of the ports in the northern range of islands* (the Bahamas excepted), the safest land to make is the Island of Desirade, near Guadaloupe; for, if you should not see other land before dark, you may haul to the northward, into the latitude of Montserrat, having nearly 60 miles to run on, during the night. Some commanders make St. Martin's or St. Bartholomew's, when bound to Tortola, St. Thomas's, St. Croix, and the islands to leeward; but in this case they should be aware of the dangerous Island of Barbuda, and also of Anguilla; for a small error in the latitude, perhaps, from want of an observation, or irregularity in the current, would place them in a very perilous situation, should they attempt to run on in the night.

Strangers should pass St. Martin's, when they make it, on the North side, the passage between it and Anguilla being clear; St. Bartholomew's, Nevis, St. Christopher's, and Antigua, on the South side. Barbadoes should likewise be passed on the South side, in order to fetch into Carlisle Bay; and Granada and St. Vincent's on the South side. No particular directions are necessary for the other islands, as every seaman knows the danger of running to leeward or past the land;—a very serious occurrence for a dull sailing-vessel.

Vessels on making Barbadoes and the other Windward Islands, when approaching from the northward, should be very careful not to cross the latitude of the low or northern islands during the night, although their reckoning may be many degrees to the eastward of the isles. The low islands on which so many vessels have been lost, are *Barbuda, Anguilla, Dog and Prickly Pear, Sombrero, Anegada*, and its *Horseshoe Reef*; of all these, the first and last are the most dangerous. Before you see Anegada, in clear weather, Virgin-Gorda, and perhaps Tortola, will be seen very distinctly; distance is often deceiving at sea, and this land, by those not well acquainted with it, has been frequently mistaken for the East end of Porto Rico; and, although directions have been given for avoiding this error, by observing that there is only open sea to the eastward of Virgin-Gorda, and that to the eastward of Porto Rico lie several islands, yet it is neceesary to observe that these islands, when the high land of Porto Rico is first discovered, cannot be seen, so that, if you make the land at the close of day, it is proper to be aware of this circumstance. It may also be remarked, that Anguilla and the Dog and Prickly Pear Isles cannot be seen until some time after you make St. Martin's, which is high land, and lying to the southward of these low isles. Barbuda is dangerous in the night time only, but to strangers also, in the day, having reefs under water all round, excepting at the extreme S.W. point.

On passing to leeward of the high islands which obstruct the course of the trade-wind, danger arises from strong gusts coming from the mountains, which sometimes dismasts a vessel. Be cautious to keep so far from such land as to be able to work your ship, should the wind suddenly shift and blow on

the shore, which it often does during the day. When the wind is baffling, you will find it advantageous to keep your course along shore so long as you have steerage-way, although all your sails may be aback; for it frequently happens that the wind comes round to its former quarter before you lose your headway, and by this one ship may get into another current of air, which brings her into a fresh breeze, while another, in company, by altering her course to get her sails full, loses the opportunity of getting into the breeze, and may be detained by calms and baffling winds great part of the day. We have often seen the after-sails filled, with the wind aft, while the headsails were flat aback, with the wind ahead, which continued so long that the foresail was hauled up to continue the headway.

In navigating among the Windward Islands, every precaution must be taken in allowing for the direction and strength of the currents. It has already been shown, in the preceding section, that the general prevalence of them is to the westward, but with different velocities, disturbed at times by the lunar influence, and varied by the contour of the coast, &c. An easterly current is seldom or never found out of sight of land, but N.W. and northerly, in the passages may generally be found; and it has been remarked that, in some instances, when the current runs to leeward on one side, it runs to windward on the other; also, that it may set to windward on both sides, while, at the same time, to leeward in the middle, and frequently the reverse.

The intelligent officer to whose book we are indebted for these observations, says, "In the daytime, attention to the progress you may make in getting to windward, by the appearance or bearings of the land, is the best rule you can have, first trying a short tack in-shore, where, if you make little or no progress to windward, your best way is to stand across, and try the other side of the channel; and, if that do not answer, the mid-channel will most likely prove the best; for, although contrary to the general opinion, we have often found it so; much, however, depends on the time of day. In the morning and evening you should endeavour to be near the shore, the North side of the passage in preference, where if the wind be moderate, and the coast not much exposed to the general trade wind, you are pretty certain of having the wind two or three points off the land. In like manner, you should endeavour to be in the offing about one o'clock p.m., as the wind generally blows more on the shore at that time. We have also observed that the land and sea breezes prevail most where the land on the coast is low.

"*Should you be bound to a place to the westward of you*, and no land in the way, the best tack to be upon is the one on which you will lie up nearest to E. by N., that being the point from which the trade wind generally blows; when it changes from that point you may consider it a slant of wind, and take advantage of it accordingly—particularly if it veer to the South during the day, or to the North by night; thus it will be found to be advantageous to be on the port tack at night, and the starboard tack by day."

In squally weather the wind is so very variable, that it is seldom possible to take advantage of it in getting to windward.

To windward of the islands and to the northward of Barbados, in moderate trade winds, the Equatorial Current will be found generally to set in a direction

from N.W. by N. to N. by W. at the rate of from half a mile to three-quarters of a mile an hour. As you approach the islands, it becomes more irregular; near to the eastward of *Point Salines*, Martinique, it frequently sets strong to North, and even N.E. We have also felt this set of the current near to Point Moulacique, the South point of St. Lucia, and have frequently seen vessels bound to Gros Islet Bay, St. Lucia, from Barbados only the night before, driven so far to the North as to have passed the Island of St. Lucia, and also a considerable part of Martinique, before they discovered their mistake; and, being strangers, they had to wait until an observation could be taken to ascertain the latitude, before they could find out their true situation.

In the passages lying nearly in a North and South direction, the current sets generally about N.N.W., until you are past the most northerly land on the eastern side of the passage, when the western current being no longer obstructed by the land, sets with great strength in a more westerly direction. This is the case in all the passages from Antigua to Hayti, and those on the South between Trinidad and Paria, and on the coast and Leeward Islands from Margarita to Buen-ayre, as the current inside to the South of these islands (in the dry season) sets about N.N.W. ½ W., at the rate of nearly 2 miles an hour. Ships running to westward, inside, should make an allowance for it, and keep a good look out, for it must be borne in mind, as already shown, that the currents here are variable, according to the season.

In order to touch at as many of the Windward Islands as possible, without having to beat to windward; suppose your vessel to be at Barbados, and you have to call at as many islands as you can, in as little time as possible—from Barbados you can steer for Tobago, hence for St. Vincent's which is as far to windward as you can fetch; and, with a northerly trade wind, you will not be able to do that. From St. Vincent's you may steer to any of the Granadines, and so on to Granada; and at times you may fetch Trinidad, but this is not to be depended on. From Granada you cannot always fetch St. Kitts, but in general, the Virgin Islands, St. Croix, St. Thomas, &c. The general course this way is to go to Tobago, and thence to Trinidad.

Another track is from Barbados (S.W. side) to St. Vincent's (South side), hence to the Granadines and Granada.

From Barbados to the N.W. you may go to St. Lucia, passing round the N.E. point of the island to Gros Islet Bay and the Careenage; from this place you fetch Port Royal Bay, Martinique, then St. Pierre, Roseau (Dominica), the Saintes, Basseterre, and sometimes Point-a-Pitre, Guadaloupe.

From Basse-terre, Guadaloupe, you can seldom weather Montserrat, unless you tack and take advantage of the variable winds under Guadaloupe, which is the best way, if you are bound to Antigua, or to the northward between Antigua and Nevis; but if not, you may pass close to the West side of Montserrat, and so steer for Nevis or St. Kitts, or to the islands to the westward; or you may pass on either side of St. Eustatius or Saba, if you can lie round without tacking, and so through the Dog and Prickly Pear or Sombrero Passage to the northward.

In steering through these passages, or across them, it is recommended to keep well to windward, as the wind will often head you as you approach the opposite side, and the currents are very strong; and it may be remarked

that, in standing to the southward, you feel the force of the current more than when you are standing to the northward.

From these remarks, and a reference to the chart of the islands, it may be readily seen what other track can be accomplished. Thus, from Barbados to Antigua, and the islands to the westward of it, you pass to the eastward of Disarade if you can; if not, between that island and the East point of Guadaloupe; when you are clear of this last point, you have Antigua and all the islands to the westward in your route.

The intercourse between Barbados and Demerara is very uncertain, and you cannot always trust to fetch from one place to the other, even in fast-sailing vessels. From Demerara you can generally weather Tobago; of course, it must always depend on the wind and current; therefore we speak in general terms only. Indeed, we have sometimes seen southerly trade winds continue for a long time, and also northerly winds; and we have seen, owing to N.E. winds and lee currents, vessels from Cayenne not able to weather Barbados, and a vessel from Antigua a month in getting to Barbados, owing to southerly winds.

In working to windward through any of the passages in the night time, it is strongly recommended not to trust to the distance run; for, although you may have an offing of 4 leagues, and you could lie up so as to make a long stretch, yet, before you have gone the distance of your offing, you will probably find it full time to tack from the shore. *In the passages lying nearly East and West*, the western current runs so swiftly, that, in standing to the southward on the port tack, and lying up S.E. by E., you will often find that you have made little or no easting. This has been the case with several vessels leaving the South shore of Antigua; they stood on, lying up S.E. by E., which course they expected to make good, and thought perhaps to weather Point Antigua on Guadaloupe, but the current deceived them, little or no easting had been made, and they ran ashore among the small kays of the Bay Mahaut, Guadaloupe, nearly due South from that part of Antigua which they had left the previous evening.

When bound to windward it is sometimes difficult to beat through the passages between the islands. Of these passages, the easiest are considered to be between St. Vincent's and Becquia, between Martinique and St. Lucia, and between Antigua and Guadaloupe. The wind, in general, blows a strong breeze, so that a vessel may carry double-reefed topsails, courses, top-gallant sails, jib, and driver. These are the most suitable sails for working the ship in the night, the weather in the passages being too generally squally. If more reefs are out, you will be liable to spring your masts and yards; for, however fine the weather may appear, strong and sudden gusts may come on several times in an hour. Finally, too much sail is hazardous, as the squalls may head you until they blow past, when you come up to your old point; and in this way it is obvious you may run a long way to leeward in carrying sail through a squall.

General Remarks on the Navigation of the Caribbean Sea, from Leeward to Windward, by Lieut. Greevelink.

The best way to beat up in the Caribbean Sea is still an object of dispute among a great many European mariners; there are some, and they form the greatest number, who always prefer the northern part; others who choose to keep in the middle between 14° and 16° of latitude; and a few, to beat up off the southern coast, till they are able to make Antigua, and run out by the channel between that island and Guadaloupe.

The first of these methods, the one generally adopted, is evidently the best; as the South coasts of Hayti and Porto-Rico are tolerably clean, and afford smooth water when the wind is to the northward of East; but in the hurricane months, this part is rendered unfavourable, not only by these dangerous visitors, but also because the currents are then often very strong in the northern channels, whereas they have, at the same time, been observed to be very weak in those southward.

The second route depends, I imagine, more on vague reports of a current setting between those parallels to the eastward; but this will, I trust, no longer be credited, at least, in the tract of sea here described. During the intervals, however, in which light winds are of some duration, the westerly current may be found very weak, as is undoubtedly proved by our passage in April, 1837. Yet this is no reason why a constant weak current, or an easterly one, should be stated when found only occasionally in those parts where they have once been met with.

The third route, by which the hurricanes are generally avoided, has been treated with too much neglect, partly by its being impeded by the Leeward Islands, and partly by the unknown force and direction of currents, and want of local experience of the coast; but hereafter I doubt not but this track will be adopted as the best in those months which threaten destruction in the northern passages, because it is almost universally followed by the coasters and pilots.

Commanders bound from one of the interior parts of the Caribbean Sea, toward the coast of Guayana, generally prefer passing out by the Channel of Antigua and Guadaloupe, which is one of the fittest for that purpose with northerly winds; but when, on the contrary, the wind is from the southward of East, I should not advise any attempt to pass that way, but to proceed directly to the North, by the westward of Barbuda, prolonging the stretch well, in order to gain, with the other tack, the windward side of the islands. In July, 1836, we laboured for several days to get out of the first-mentioned passage; and in August, 1835, we were happy enough to reach English Harbour, though unable to effect our purpose of getting into the main sea, being harrassed by south-easterly winds and strong westerly currents.

After having reached the Atlantic, when destined toward the coast of Guayana, it is best to deep your wind, if blowing from the northward of East; as, in that case, it may enable you in one stretch to make the desired port; but, with unfavourable winds, I think it advisable to run straight for the coast, and beat to windward along the bank of soundings. This is most probably

attended with less loss of time than the working to the eastward in higher latitude, which may be proved beyond any doubt by comparing some of the many instances which have occurred of vessels falling to leeward of their port of destination, and trying to regain it by making a long stretch to the northward; when, after fourteen days, they made the coast nearly at the same place; with those of others who effected it completely in only three or four days, in the space mentioned. I know many reports of this sort, but they want sufficient authenticity to be relied on.

As a general remark, it may be kept in mind that to get soundings ought to be the principal object of ships bound to this coast, as, with the present knowledge of depths hereabout, together with an observed latitude, it may show them their place of situation East or West of the intended place very near the truth, because the general tendency of the mud-bank is nearly N.W. and S.E.; and thus, to the eastward of a certain meridian, there will be found more water than to the westward, upon the same parallel.

It is absolutely erroneous to state, that the limit of soundings is marked by the change in the colour of the water; as more than once, and particularly in November, 1834, in 25 fathoms of water, to the N.E. off Marowyne River, the colour was perfectly blue and transparent, and at other times tinged of an ashy hue by the mud.

Steam Navigation between Tobago and Demerara.

We take the following from an illustrated work,* which gives numerous directions for the West Indies:—

"Between *Tobago* and *Trinidad* the current sets along towards the W.N.W. and W.S.W., almost always at the rate of 2 knots per hour, and not unfrequently 3 or 4 knots.

"After clearing the channel, the stream will generally be found running nearly parallel with the line of coast the whole distance to Demerara, though it sometimes takes a more northerly direction, particularly in the months of July, August, and September.

In shaping a course, therefore, for Demerara, vessels should keep well to the eastward of the port, not only to avoid the banks off the mouth of the *Essequibo*, but because the objects to the eastward are more remarkable, which is of the utmost consequence on a coast where its features bear one uniform appearance, without a hill, the bearing of which would point out a ship's position; and the land so low that vessels may be aground before it is visible. The *lead* will be found the best guide, as the soundings very gradually decrease, and there is no danger while navigating in 7 fathoms water."

The most remarkable features of the coast eastward of *George Town* are the *chimneys* of the *boiling-houses*, and a remarkable row of *cabbage trees* about 12 miles from the lighthouse. There is also a singular tree about 15 miles

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* "Practical Observations on the West India Navigation," by a Commander of one of the Royal Mail Steam Packets. London, 1844.

from the point of *Corobana*, called *General Murray's Tree;* it is most conspicuous when seen at the termination of a point.

Demerara.—This port should never be taken by a stranger without a pilot; indeed, even those who are most intimately acquainted with its localities, in vessels drawing more than 12 feet water, should always take this precaution.

In a steam-vessel the navigation is most simple at proper times of the tide.

Navigation to Jamaica *via* St. Juan, Porto Rico, Cape Haytien, and St. Jago de Cuba.

Steamers leaving *St. Thomas's* to perform the *Jamaica* route, *via* the North side of *Porto Rico* and *Hayti*, should leave the small islet of *Bergantin* (which is a high rock resembling a ship when at a distance), on their left; and *Montalvan* and *Cabrito* on their right, bearing in mind that a *reef* extends from Montalvan a good cable's length.

After passing *Culebra* and *Culebrito*, I should recommend shaping a course to pass outside a *rock* on which the *Barossa* is said to have struck; for although it seems to be doubtful, yet masters of *Porto Rico* vessels have assured me it does exist. From their statements I am inclined to believe that it is considerably nearer the shore.

San Juan Harbour will readily be distinguished by the *Moro*, which, when first seen, makes like an island having extensive fortifications on its summit, rendering it exceedingly remarkable.

This *Moro Castle* is on the East side of the entrance, and is steep-to within half a cable's length on its northern side. The position to lie-to for a pilot is about 2 cables North of the Moro, with the ship's head off shore, taking great care not to drift near the *low rocky island* on the western side of the entrance, which has much foul ground around it; and the current generally setting strong in that direction.

The harbour is not difficult of access by day, but at times the sea breaks right across the entrance, which calls for the promptest attention at the helm.

I do not consider it safe at any time to enter this port at night in large ships. Rise and fall of tide, 2 feet.

From *San Juan* a course should be shaped so as to pass 6 or 7 miles from *Cape Viejo Francais* (Hayti), making allowance for a current which sets towards the Porto Rico coast, when within the distance of 10 miles from the shore. The first land that will be seen on this track (after losing sight of Porto Rico) will be *Cape Raphael*, which is of moderate height, and is the termination of the high land; the coast thence to *Cape Engano* being exceedingly low. *Raphael* may also be known by a small conical hill (*Mt. Redonda*), a short distance inland, which, on coming from the N.W., is seen near the termination of the point.

The next cape to the N.W. is *Cape Samana*, which makes like an island on many bearings, particularly from the N.W. After passing Cape Samana,

Cape Viejo Francais will be seen, which also makes like an island with low points at each extremity.

Cape Isabella is the next headland, which is very low, and, like Cape Viejo Francais, also makes like an island. Between these two capes there is a *remarkable high hill*, sloping down to the water's edge, with a flat summit, and a remarkable *notch* on its extremity when seen from the N.W. This land is *Cape Casrouge.*

The *Grange* is the most remarkable object, and cannot be mistaken for any other part of the coast if attention be paid to the book of directions.

Vessels may pass inside the Monte Christi Shoals; but as the channel is not well known, I have invariably gone outside, on the principle that a steamer's progress is so rapid through the water, that in a very short period of time after shoal water is descried, the vessel is on shore. Although I have adopted this line of route, I have, on former occasions in H.M. ships passed inside, and am well aware that there is a good channel; but a large chart of this portion of the coast should be in possession of the commander before he navigates his ship in doubtful water.

Cape Haytien is a high cape, sloping down towards the East, and having a small *rock*, called *Picolet*, at its foot, presenting the appearance of a *white* patch when first seen from the eastward. The water is deep tolerably close to this rock, and it may be approached to the northward without fear.

I should, however, recommend all vessels to go in at slow speed, with strict attention to the *lead*, as the late earthquake is likely to have changed the face of nature in the bottom of the sea, as well as on the land.

From Cape Haytien the course should be shaped to pass between the *Tortugas* and *Hayti*, in which channel there is always much less sea than outside, besides being a more direct course.

St. Jago de Cuba.—This harbour cannot be taken at night, and never even during the day without a pilot, as it is exceedingly narrow, and the greatest attention is required at the helm, owing to the sudden turnings in the channel.

From St. Jago de Cuba to Morant Point, I would recommend a course to be shaped (during night time) 15 miles to the West of the *Formigas*, as I have on more than one occasion experienced a set in their vicinity of half a mile an hour to the N.E. This is by no means a usual occurrence, but knowing the existence of deviations from the general set of the stream, it is as well to be on the guarded side, more especially as the saving in the distance is very trifling.

Morant Point is very low, with a *lighthouse* upon its extremity having an excellent *revolving light*, which may be seen 16 or 18 miles distant. From the Point to the *Keys of Port Royal* it is only necessary to run down about 2 miles off shore, taking great care at night to avoid the low land about *Cowbay Point*, which is very deceiving.

On returning by this route, the foregoing observations will be equally available. It is, however, perhaps as well to observe, that after leaving St. Jago de Cuba great advantage may be gained by keeping about 2 miles off shore, where there is frequently a weatherly set, and invariably less current.

In making *Porto Rico* from the westward the land is low, gradually rising to a high chain of hills; thence, trending East, it again falls, and then rises

to another chain of mountains called *Luquillos*, which terminate in low land at the eastern extremity of the island. *St. Juan* may be known by its situation between the above two ranges of mountains, and by having on its West side a number of remarkable hillocks in the form of *haycocks*, which are frequently seen before the *Moro* shows itself; but the fortifications are most commonly the first objects descried. I would also caution vessels to be extremely guarded at night, in not mistaking the channel between Culebra and Porto Rico, which is exceedingly dangerous. The distance run by the ship after leaving St. Juan will of course be a good guide, but between August and October the currents are often so variable, that the most careful navigator may be deceived in hazy weather, or at night, as there is under these circumstances a great resemblance between Culebra and St. Thomas's. The latter, however, if seen before sunset, may be distinguished by its being higher, and making in *three* small *peaks*.

From the mean of several observations, I have found the current along the Porto Rico coast and Hayti to the northward to be as follows, though the very unusual state of the weather in the West Indies of late has rendered these very uncertain, and therefore great care should be taken in ascertaining the direction of the stream, always distrusting published accounts.

Between 18° 29′ North latitude and Porto Rico, the current generally sets obliquely on the shore towards the E.S.E. Between 11° 29′ N. and 18° 39′ N. it runs to the E.N.E. To the northward of this latitude the stream takes a more northerly direction, particularly in the vicinity of the *banks* of the *Bahamas*.

To the distance of 10 miles along the *Hayti North Coast* the current frequently runs towards the shore, but beyond that distance it takes the direction of the coast.

During the hurricane months it should be remembered, that the currents are more uncertain than at any other period."

Navigation between Grenada and Jamaica, along the South side of Hayti to Jacmel.

Leaving the island of *Grenada*, the current will almost invariably be found setting between W.S.W and W.N.W., but more commonly in the former direction than the latter. It is generally strongest between December and April, and of least force in the hurricane months; indeed, between July and October (on reference to former journals), I find not unfrequent sets to the East and N.E., particularly when hurricanes have visited any part of the West Indies; but except in these months it is very rare to find the stream deviating from the W.S.W., W., or W.N.W.

Alta Vela.—This little island lies about 16 miles S. ¼ E. from *Beata Point*, in lat. 17° 28′ 40″ N., and long. 71° 39′ 30″ W., and is directly in the fairway of the steamers coming from *Grenada* to *Jacmel*. It is high, barren, and quite bold close-to, and may be seen 25 or 30 miles distant, making in a peak.

The course from this island (*Alta Vela*) to *Jacmel* is N.W. ½ W., about 67 miles; on which line vessels will make the *Frayles*, which lie about 10 miles

from *Beata Island*. They are a cluster of steep *reddish*-coloured *rocks*, and are said to be steep close-to, though from the imperfect survey of this part of the coast I would advise ships to give them a berth of a mile at least. For the above reason, also, I would not take the channel between *Alta Vela* and *Beata Island*, as scarcely anything is to be gained by it.

The current most commonly sets very strong to the westward in the vicinity of the islands; but after passing the *Frayles Rocks* a strong S.E. set is frequently experienced, particularly during the night, when the trade does not blow home.

From *Jacmel* to *Jamaica*, shape a course so as to pass 5 miles clear of the *Isle of Vache*, which is about 8 or 9 miles in length, and makes like a group of small islands when first seen, particularly from the westward. The current between this island, and along shore to *Jacmel*, generally sets to the westward, but when within 5 or 6 miles of the shore, an easterly set is frequently experienced, particularly at night.

The first headland after passing the *Isle of Vache* is called *Abacou Point*, low at its extremity, then suddenly rising to a moderate height.

The next cape to the westward is *Cape Gravois*, which is very low, the land between being of a moderate and equal height. From this cape to *Tiburon* the land becomes very high. The cape itself (Tiburon) is of moderate height, but a short distance from its extremity it suddenly rises to a high mountain, and when first made from the sea, appears to slope down to the water's edge.

The *Isle of Saona* is situated at the S.E. extremity of *Hayti*, and is very low, level, and covered with trees. In running past this island, shoal water will be seen some distance from the shore. At night I would recommend running 10 or 12 miles to the eastward of the reckoning, when bound through the *Mona Passage*, as it is the *turning point*, and being very low, ships would be in the reefs before seeing the land, except with clear nights.

Jamaica to the Bar of Maracaybo, April and May, by Captain Dunsterville, R.N.

On sailing from Jamaica we had fresh easterly winds and squally weather, then winds variable round the compass.

From *Alta Vela*, in lat. 17° 28′ N., long. 71° 40′, we took our departure for the Isle of *Oruba*, on the eastern side of the Gulf of Maracaybo, allowing for the strong westerly currents above three-quarters of a mile an hour.

Saw the *Monks*, which are rather high rocks; and, by the altitude of the star *Antares*, made the northern one to lie in lat. 12° 28′. Hauled to the S.E., and ran along the western coast of Paraguana, sounding, when distant from the shore about 3 miles, from 12 to 8 fathoms, till we arrived at *Punta de los Estanques*, whence we took our departure for the Bar of Maracaybo, S.W. ½ W.

To the eastward of the *Bar of Maracaybo*, about 8 leagues, are high mountains; the land westward of these is low, and continues so, with occasional breaks in it, by kays and hillocks, which are at the entrance of the lagoon. Further westward are two pieces of land, not particularly high, on the low

S E. termination of which are three little hillocks. This is the *Isla Todos*, on which stands the Castle of St. Carlos. When bearing S.S.W. ¾ W. the hillocks are over the fort, which is white. Do not steer for the latter, but continue on about West, not going into less than 5 or 5½ fathoms, when you will open the ruins of Fort Zapara to the southward, and the Castle of *Bajo Seco* to the westward, in lat. 10° 59′, long. 71° 42′. This fortress is, likewise, white, and is situate on a small sandy kay. To the westward of this lies the bar, having at this season a depth over it of only 11 ft., hard bottom; but in the rainy season, August, September, and October, there is, at least, 13 ft. of water.

The breezes here are very heavy from the N.N.E. to N.E. by E. in the early part of the year; yet at about 8 a.m. the wind is generally more moderate; and from 2 p.m. to 2 a.m., in the following morning it blows a perfect gale, with a heavy sea, which makes it dangerous to lie at anchor here.

The best anchorage off the bar is in 5 or 5¼ fathoms, with the Castle of Bajo Seco South or S. by W.; off shore about 3 or 4 miles. The soundings on the South side of the gulf [bay ?] are regular, decreasing gradually as you approach the shore. The current runs to the N.E. when the moon rises; and it is high water, on the full and change, at $5^h\ 15^m$.

In beating to windward, endeavour to be near the north-western shore at about 1 p.m., in order to take advantage of the winds which draw to the N.N.E., so as to make a good lay to the eastward.

The communication with the city of Maracaybo is kept up by one of the ship's boats, hiring a pilot for the occasion, who, on making the general signal, will come out from Bajo Seco in a boat with latine sails, should the weather be moderate. If you have to communicate frequently with the city, or to cruise in the gulf, I should recommend beating up to the anchorage of Estanques, in the Peninsula of Paraguana; but, in beating up, do not go to the eastward of Punta Gorda, the S.W. point of Paraguana.

The *Anchorage at Estanques* is very good for a vessel of the largest class, even within half a cable's length of the beach, and capable of containing twenty sail in safety. The best marks for assisting a stranger to find the anchorage is the Mountain (or Pan) of *Santa Anna*, which much resembles Vesuvius, and may be seen, in clear weather, 8 or 9 leagues off. This mountain, when bearing E. ½ N., leads to the anchorage. The place may also be known by being a long tongue of sand, with some huts on the extreme point, occupied by fishermen, who in the season, take immense quantities of fish by the seine. The *Bustard* anchored in 4½ fathoms, and veered to 25 fathoms on the N.E. anchor (from which quarter the prevailing winds come strongly), and 82 fathoms on the best bower to the S.W. Point Estanques, S. ½ E., Point Salines, N.N.W. ½ W., off shore 2 cables' lengths. No supplies can be obtained here. Rabbits may be shot, but can be purchased cheaply. The little water that may be procured is muddy, and not fit to drink.

If you are bound to the eastward, when clear of the gulf stretch to the northward, as the currents run so strong between the Isle of Oruba and Cape St. Roman, that it is nearly impossible to beat through; but

should you go between the island and main, be cautious in standing by night to the S.E, as the coast from Cape Roman to Aricula (S.E. 19 miles) is very dangerous, and the currents thereon.

In stretching across, from *Point Chicabacoa*, on the West side of the mouth of the gulf, to Jamaica, we found a strong current, running due West nearly 1 mile an hour.

The Channels of Providence.

The *Channels of Providence*, between the Great and Little Banks of Bahama, are copiously described in the Sailing Directions mentioned below, as well as the winds and seasons of this portion of the West Indies. The lighthouses on Gun Kay and the Great Isaacs in the Florida Strait, together with those erected on the Florida Reefs by the United States Government, and the fine line of beacons along the face of the latter will be eminently useful in facilitating the navigation. We have been assured, by an intelligent navigator, that it is not unusual for twenty sail of vessels, of from 100 to 400 tons burthen, to pass the Great Stirrup Kay within musket-shot, and even within hail, in one day; these, for the most part, proceeding from the United States to Cuba and the Mexican Sea. They make the Hole in the Wall, now distinguished by its lighthouse, then the Stirrup; thence, if the weather appears threatening, they pass through the N.W. channel; otherwise they shape a course, picking their way, across the Bahama Bank, to the southward of the Cat Kays, beyond the Gun Kay lighthouse. Here they enter the Florida Strait, and pursue a southerly course, where the Gulf Stream is found, as described, to run with the least velocity to the northward. —(See further, "Sailing Directions accompanying the Chart of the Windward and Gulf Passages," published by Mr. Laurie.

Directions for Proceeding to Demerara, etc., from the N.E.

In the third volume of the "Colombian Navigator," pp. 128 to 160, we have given a copious description of the coast, and directions for making the rivers of Guayana. To that description &c., the following remarks in addition, by Captain George Cheveley, will be found a useful and valuable addition:—

"If, when in lat. 10° N., the water changes to a dark or black colour, or dirty drab, and then in 8° turns again to the usual sea blue, you may rely on being to windward. There are no soundings, only this remarkable change.* You will then, in running further in, on the coast, observe a perfect division, or line of change, on the water, nearly N.W., from blue to

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* This discoloured water appears to be in the stream of the *Equatorial Current*; as may likewise be that which is met with at 80 or 100 leagues to the East of Barbadoes.—Ed.

green, where the current sets strong in that direction. On proceeding, you will again change to thick muddy water, influenced by the tides, which should be carefully calculated and allowed for. Many ships have run to leeward from want of this, and a due allowance in the course when the tide is running, which is always with the flood. As you approach in-shore 4, 5, and 6 fathoms, should the water then be of a *red* colour, you may make sure of being to windward, and need not fear running, even should you obtain no pilot. This is most perceptible from Miconie down to Corobana Point: to leeward all is dirty, thick mud.

"The lighthouse on the weather point of the Demerary River shows a bright fixed light to seaward, from 12 to 14 miles; with this light-tower bearing from South to S. ¼ W., flood making, you cannot do wrong by steering in on that course, should you not obtain a pilot, and come-to off the fort, keeping outside the poles on the West side. I mean this as a safe plan for a stranger.

"The deepest of the channel has worked of late much to windward; and deepened so as to allow vessels of 17 and 18 ft. draught to beat out in two or three tides. I ran in without a pilot in April, 1830; was on the bar at dead low-water spring tides, least water 2 fathoms, and am convinced 11 ft. may always be found. The pilots, of course, wish the bar to be thought shoal and dangerous, and endeavour to keep in ignorance those who should make these things more a matter of study than is at present the case."

The following is by Capt. Henry Faithfull, June, 1865 :—

"In making the land to the eastward of Demerara River, the coast is very low, and scarcely above the high-water level—the sea at that time rising into the jungle when the tops of the trees alone are visible at the distance if 10 miles off the shore; the sameness of the whole coast is such that it is impossible to say where you are by the look of the trees, consequently the lead is the only sure guide by night or day. Soundings may be obtained 150 miles East of the lightvessel, in 35 fathoms, much sand, little mud, and small stones; the nature of the ground changes as you advance to the westward—less sand, more mud, and no stones,—until in 12 fathoms it is all mud. During the night or early in the evening, it would be advisable to make Berbice light-ship, which, under ordinary circumstances, cannot be mistaken for the Demerara lightvessel. It is well in sight from the deck when in 13 fathoms, mud, and is about 66 miles from Demerara light-ship, to which the course is about N.W. by W. by compass, but allowance must be made for tide—flood setting S.W., ebb N.E.,—the average strength of the flood being 2 miles, of the ebb 3 miles,—increasing the ebb in the rainy season to 5 miles and decreasing the flood to 1½ miles per hour. By constantly keeping the lead going, and subtracting ¼ of a fathom from the soundings for the lead sinking into the mud, you will not get into danger, but on no account should a vessel be brought into less than 6½ fathoms by night or day; there is no danger of missing the light-ship in this depth; she is anchored at 3½ fathoms low water, rise and fall 9 feet. At night time, in coming from the eastward the *revolving* light on the point, visible 16 miles, will be first seen; if not bearing to the southward of West, haul out immediately—the tail of the Litchfield Bank, with 8 ft. at low water, is

between the ship and light-vessel, and your ship is in danger of sticking in the mud; when the light-vessel is seen bearing West, steer for her, and round-to, to westward, as close as possible; a pilot will be sent immediately, day or night.

"The three great things in coming up this coast are *Lead, Lead, Lead.* In case of getting ashore on this coast, there is no fear of the vessel going to pieces—the bottom is too soft; but there is no landing on the coast, for it is too muddy; the boat that leaves the ship to get assistance must find a creek or trench, and go up it at high water; she is sure to find a plantation a few miles inland, and can then send to George Town for assistance; once on shore and requiring steam, the commander may think himself very lucky if he gets off under £1,500.

"In the rainy season the wind is frequently from the westward. In beating up do not come into less than 7 fathoms—under that the rollers have too much power over a ship in light winds; should a vessel get under that depth in a calm, or from the wind having suddenly failed, with flood tide, anchor immediately with 60 fathoms of chain—getting under weigh again when tide is done. These directions refer to ships of 1,000 tons, and not to coasters. If coming from the northward in 8° N., you have 32 fathoms, the light-ship bears due South of you; if more, you are to the eastward; if less, to the westward. This rule holds good up to the light-ship."

8.—OF SHIPS BOUND TO AND FROM THE NORTHERN PORTS OF AMERICA.

In the introductory remarks to this section of the work, we have alluded to the principles of great circle sailing, and have pointed out the advantages which it possesses, not so much in the shorter distance which it gives over the rhumb course, but in the scope it allows the navigator in the choice of a parallel on which he can make a good passage, without materially increasing the actual distance to be sailed over.

In no case can this be better exemplified than in the course over the northern parts of the Atlantic, between the British Isles and the northern American ports. We alluded to a case, not impracticable, of the courses between the Lizard and Cape St. John's, in Newfoundland, and showed that two courses might be taken not more than 35 miles greater than the *shortest* distance, of exactly the same length, and yet be 350 miles apart in latitude in their greatest separation.

An *imaginative* course will well explain for our present purposes:—From the Lizard to Sandy Hook, New York, the distance and course by compass are 2,952·5 miles S., 78° 51′ W. But if a vessel leaving the Lizard were to commence sailing N. 73° 24′ 40″ W., and passing about 85 miles southward of Cape Clear, gradually bearing to the West, attaining a maximum latitude of 51° 56′ 30″, long. 26° 27′ 20″ W., and then, if it were possible, approach New York on a S. 54° 36′ W. course, she would sail over 2,865 miles, or 87½ miles less than the compass course. This *great circle course* passes over Cape

Bonavista and La Hune Bay in Newfoundland; St. Anne's Bay in Breton Island; Pictou and Cape St. Mary in New Brunswick; near Boston, New London; and over Long Island, in the United States.

A line of the length of 2,952·5 miles, placed in a higher latitude than the rhumb line, as shown in page 446, is just as much *above* the great circle course in latitude as this is above that by compass. This corresponding arc from New York leads considerably inland of the coast of the Eastern States, intersecting Chaleur Bay, Cape Bonaventura in Gaspé Bay, Anticosti, passes 45 miles N.W. of the Strait of Belle-Isle, approaches within 189 miles of Cape Farewell, Greenland, attains a maximum latitude of 57° 12′ N., and intersecting the S.W. part of Ireland, at Kinsale, reaches the Lizard in a S.E. direction. These two lines, of the rhumb and the corresponding arc, are *upwards of* 700 *miles apart* at the greatest deviation from each other.

With these considerations so manifest, we shall be better prepared to understand that a higher latitude than the usually received one cannot, of itself, be disadvantageous; and by the excellent observations of Captain Hare, presently given, will be more clearly evident. See also pp. 243—250.

By referring to the Chart, it will be seen, that from the Land's End of England to St. John's, Newfoundland, the true bearing is W. 4° S.; and from the same point to Cape Sable, or the S.W. end of Nova Scotia, it is about W. 9° S. But the circumstances of navigation in general render a direct course more tedious and difficult than a circuitous route, and the best passages have been made by pursuing a *high northerly course.*

It seems probable, from all that we have said on the winds and currents, that on prosecuting a north-westerly course, from the Bank of Channel Soundings, the winds and currents respectively may counteract and balance each other; that, on further prosecution of the same course, the winds will be found less westerly, and therefore more favourable than in the more southerly parallels; and that, in advancing toward the mouth of Davis's Strait, the advantages both of wind and current may be combined.

Caution must be taken not to advance too near the eastern coast of Newfoundland, if bound to New Brunswick or the southern ports; nor to the eastern coast of Breton Island, as here the vessel may be swept round by the strong westerly currents, which have been described in the preceding pages (424 to 432), and which, now understood, instead of producing mischief, may prove highly advantageous in facilitating the ship's course.

The propriety of these arguments was confirmed by experience, in more than forty passages made to and from New Brunswick, &c., by Lieut. Chas. Hare, of the Royal Navy, previous to the fall of 1824. Annexed is a copy of that gentleman's communication.*

"Ships from Scotland, in the spring of the year, and bound to New Brunswick, have always arrived sooner than those from the English

* Many succeeding passages made by Captain Hare, since 1824, have concurred to prove the propriety of these directions, which have been highly approved by the American captains of home ships, as well as by British masters. This gentlemen had crossed the Atlantic for the ninety-eighth time, in the year 1839, and the *one-hundred and eleventh* in 1846.

Channel; which is attributed to their being more to the northward on leaving the land.

"Ships from Liverpool generally arrive before those which sail from the English Channel; the cause being the same.

"In the spring of the year, I would never go to the southward of lat. 46° or 47°, until I reached long. 37° or thereabout; then edge to the southward as far as lat. 43°, in order to avoid the icebergs, keeping a very strict look-our; this parallel (43°) I should endeavour to preserve, or nearly so, but nothing to the southward, until up to Cape Sable, Nova Scotia; for it carries you to a safe and proper distance from Sable Island, a place that cannot be too much dreaded. In this track you will be without the northern edge of the Gulf Stream, and assisted by a south-westerly current from the Banks until past that island.

In the fall of the year my track is far more to the northward than in the spring. On leaving the land as late as the middle of October, or thereabout, I generally steer to the north-westward until I get as far North as 55°, and until I enter the longitude of 30°, then edge to the southward, to enter the banks in lat. 46°, shaping again a course to pass about 60 miles to the southward of Sable Island, as above. If bound to Halifax, and very sure of my latitude, I might be tempted to pass to the northward of Sable Island; but, at all events, it would be at great risk; and I should not, under any circumstances, recommend a stranger to attempt it, as the weather is mostly foggy, and the set of the currents unaccountable. The soundings on Banquereau are incorrectly laid down in every chart that I have yet seen; being, in fact, within an hour's sail of the N.E. bar of Sable Island; from which cause I once very narrowly escaped shipwreck. Numerous gannets are always hovering about this island, and are a very excellent indication of your near approach to it, particularly on the South side.

"By crossing the banks thus far North, you will find the advantage as you approach the longitudes of Newfoundland and Nova Scotia; the strong N.W. and North gales having then commenced, you will frequently be compelled to lie-to for two or three days; and should then ensure sufficient drift, before you are blown into the strong influence of the Gulf Stream; which would be the case at a few degrees to the southward, and inevitably in a S.S.E. direction, at an inconceivable rate. Last November (1824) the case occurred; the vessel being hove-to, under main-topsail and storm-trysail to the westward of the banks, in lat. 45°, was, in four days, swept into lat. 39½°, consequently into the Gulf Stream, when the longitude became also considerably affected, and I took the first opportunity of making a N.N.W. course, to get out of it as soon as possible.

"To prove the advantages of a northern track, late in the fall of the year, I may notice that I have, in one or two instances, read in the American newspapers the accounts of very long passages experienced by ships which met heavy gales in the latitudes of 35° and 38°, when several vessels were disabled, and others suffered loss of sails; yet, *on the same day*, in lat. 54°, I had moderate weather from the N.N.E., with top-gallant studding-sails set; which strongly encourages me to believe, that the blowing weather, incident to approaching winter, commences southerly, and inclines northerly

as the season advances, and not the reverse; an hypothesis generally formed by English ship-masters, but, in my opinion, certainly erroneous.

"I am further of opinion that the influence of the Gulf Stream, in the parallels from lat. 35° to 42°, whether from the warmness of the water or other natural causes, has a strong tendency to attract the wind from a western direction; as I have invariably found the wind more alterative in the northern latitudes before mentioned than the southern ones; and it unquestionably must be allowed by all mariners of any observation, that gales experienced in the Gulf Stream or its vicinity blow with much greater violence than they do in that part of the Northern Atlantic not under its influence; besides, the squalls from the southward or S.W. are much more sudden and heavy, and near the banks they are attended with dangerous lightning. The thermometer (an instrument easily understood) is of the greatest importance for ascertaining your approach to it; and, if bound to the West, I would, for my own part, endeavour to avoid its effects as cautiously as a lee shore; for it may be depended on, that no ship, however well she may sail, will effect westing in the Gulf Stream with a wind from that quarter; and it is to be remembered that its velocity is accelerated according to the strength of those winds; and its extent in breadth, at a few degrees to the westward of the Azores, is many more degrees than is commonly supposed.

"These observations, I hope, may be useful to my brother mariners engaged in these voyages; and permit me to say, that they are grounded on the experience of more than forty times crossing the Atlantic in the Royal and the merchant service, and in the command of vessels in both; latterly in one of 400 tons burthen, the *Waterloo*, owned in St. John's, New Brunswick; and, as the custom-books in Liverpool can testify, landed four full cargoes in thirteen following months; which, including the time required to discharge the same, then load out to St. John's, there discharge and load home again, leaves but very little time for the ship to cross the Atlantic eight times in fourteen months, which, in fact, was done.

"Still further, in corroboration of my approved northern track, allow me to observe, that in the fall of 1823, by keeping a high latitude, the brig *Ward*, myself master, also owned in New Brunswick, performed a voyage out and home in seventy-two days. The same vessel, likewise, on the 3rd of October, 1824, left the English Channel, and arrived again in the Downs on the 3rd of January following.

"I must add, that a strong, well-found, and well-manned vessel, alone can perform these voyages; for they must be maintained with unremitting attention and perseverance.

"The necessity and propriety of the above remarks were particularly exemplified by the *Ward*, which, on her passing through the Downs, in 1824, left ships there which were bound to the westward, weather-bound, and found them there on her return, having been driven back by adverse winds; while she, getting out of the Channel, performed with ease a prosperous voyage to St. John's, New Brunswick, and back, exactly in three months, assisted by chronometer, thermometer, &c."

Although the voyage to and from North America, between the parallel of 60° and 40°, has always been attended with a degree of peril from masses

of ice which drift to the southward, during the summer months, from the polar regions, yet many an unwary mariner makes his run across the Atlantic without any apprehension of meeting these floating dangers, or without sufficiently exercising a proper discretion and vigilance to guard against coming in collision with them. Commanders of ships should therefore, bear in mind the imperative necessity there is for using their utmost vigilance and attention when crossing the above-named parallels, especially between the meridians of 30° and 60° W., to guard against coming in contact with these formidable dangers of the ocean. Upon the subject of the ices which come down from the northern latitudes, much that is interesting and necessary to be known will be found in a former part of this book, pages 432 to 441.

The *New York packet ships*, when making their winter voyage from Liverpool, kept in high latitudes until nearing Newfoundland. This they did for the twofold object of avoiding the tempestuous weather so generally experienced to the southward, and of obtaining fairer winds; and thus by slipping within the mighty stream from the Florida Channel, they evaded its retarding influence. The voyage by this route is shortened; and, although bad weather must be expected, it is not so violent as further South; besides which the eastern currents are avoided.

Gulf of St. Lawrence, &c.—Those bound to the Gulf of St. Lawrence, after passing to the southward of the Virgin Rocks, on the Grand Bank, and the Island of St. Pierre, should keep a middle course between Newfoundland and Breton Island; not forgetting what has been heretofore said on the winds and currents. Recollecting also, that the harbours on the coast, westward of Fortune Bay, are impeded with dangers: there are many rocks about the entrances, and many of the harbours are imperfectly known. The rocks are not to be seen in thick weather, and fogs very much prevail on the coast.

Commanders of vessels bound to the Gulf of St. Lawrence will do well to observe that, off the South coast of Newfoundland, between the meridians 55° and 56°, and the parallels of 45° 20′ and 46° 15′, is a deep gully in the sea, extending in a true N.N.E. and S.S.W. direction, and separating the Bank of St. Pierre from the Green Bank. *The method adopted by the French vessels bound to St. Pierre for making that island is as follows:*—

From the longitude of 52° W., in lat. 45°, they steer a N.W. course by compass, which carries them across the Green Bank, in 48 fathoms of water; and when on the meridian of 55° 10′, in about 45° 35′ N., they suddenly deepen their water, from 45 to 90 fathoms. A further run on the same course of about 10 miles carries them across this gully, when they shoalen their water again to 35 and 30 fathoms; and, after a further run of 24 miles, they steer about N.N.E. directly for the island, and seldom or never miss it.—(*See the Chart of Newfoundland, &c.*)

Those who have lost their reckonings, on finding this gully, which may

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* See the remarks upon the Gales of the Azores, in the description hereinafter given of those islands.

be known by the water shoaling on the East and West sides of it, an experiment that is frequently made for ascertaining whether they are actually in it or not,—may safely take it as a *fresh departure.* Commanders, not being aware of it, when they have found their water deepen from the Green Bank to the westward, have imagined themselves entering the Gulf of St. Lawrence; and, by steering a course too far to the *northward*, have been lost to the eastward of Cape Ray, on the rocks of Newfoundland. The length of the gully is about 60 miles, in a true N.N.E. and S.S.W. direction, and the middle of it is in lat. 45° 50′, and long. 55° 15′.—(*Communication of the French Commandant to Captain Sir Richard Grant. R.N.*, 1853.)

The little Island of St. Paul, which lies to the north-eastward of Cape North, now distinguished by its lighthouses, is bold-to, steep, and high, and, with a good look-out in the daytime, cannot be considered as dangerous even in thick weather. The land of Breton Island is very high, and, though fogs are about it frequently, it is seldom so much obscured as not to be seen in time. On entering the Gulf, the Magdalen and Bird Islands with their lighthouse will be seen, as they lie in the direct course from Cape North to the River St. Lawrence.

There is, in clear weather, a safe passage between the Bird Islands and the Magdelens; but, in thick weather, it is advisable to keep either to the southward or the northward of both, as the wind may permit.

In Pleasant Bay, on the S.E. side of the Magdalen Islands, there is clear and good anchorage, very near the shore; and it is a very safe place for vessels to ride in, with a westerly wind, and infinitely preferable to beating about in the gulf with a foul wind. There is a safe passage into it between Amherst Island and Entry Island.

As the weather to the southward of these islands, between them and Prince Edward Island, is generally much clearer than on the North, the passage that way is preferable, particularly after the early part of the year, when S.W. winds mostly prevail.

Vessels bound to or from the River St. Lawrence now use the Strait of Belle Isle, as a channel which gives the shorter and better route to Europe *in the summer months.* It should be remembered that the ices described in (331), (pages 435 to 439, which float down the Labrador Coast to the Great Banks, have to be carefully avoided during the season of their frequency in February or March to July. Again, the shorter days in the higher latitudes, and the prevailing fogs which infest the Newfoundland coast have to be taken into account during the winter and late autumn months. The lights on Belle Isle and Amour Point, in the Strait of Belle Isle, will very much facilitate the navigation thus pointed out. With the caution thus indicated, this route offers many advantages. The Canadian mail steamers now follow it, although an accident from ice to one of them, in the month of May, 1861, will act as a warning.*

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* When within the gulf the northern shore should not be made too free with, as it is possible that some outlying rocks may have escaped the vigilance of the Admiralty surveyors. The *Grange Rock*, off Coacoacho Bay, is an example The S.S. *North America* discovered it by striking on it in September, 1858. It is 1½ mile outside the line of dangers, near a spot where the Admiralty chart showed no bottom at 47 fathoms.

9.—BETWEEN EUROPE AND NEW YORK, &c.

There seems to be little hope that much can be added to our knowledge of this well-beaten track, and that the passages can be shortened by adopting any fresh route. Soon after Maury's Pilot Charts, an analysis was made of them in order to find out the best route by *computation* for each month in the year, of a track between New York and Europe.

It is only in quite recent years that any attempts have been made to reduce the winds of the northern portion of the North Atlantic to any system, and at the present time the increased knowledge is not sufficient to justify the alteration of those tracks across the Atlantic, which experience has proved to be most advantageous. In the future, when the *reason* of the superiority of one route over another, and the progressive seasonal changes of the wind, current, &c., are more fully understood, we may expect the passage to be shortened. One feature helping in this direction we may mention, and that is the recently discovered mode of progress of the air across the British Isles in an easterly and north-easterly direction. This is described in (92) p. 249. Of the occasional progress of storms (or areas of low barometric pressure (around and into which the wind blows) across the whole breadth of the Atlantic, we have good evidence, see (90), (91), pp. 243—249, and in a recent publication of the Meteorological Office,* Captain Toynbee remarks, in speaking of the synchronous charts which illustrate that work :—"The advantage of such charts to navigators is that they give a picture of what was going on over the whole Atlantic at the same moment of time. By comparing successive charts they also show any changes which had taken place during 24 hours. For instance, the wave-like shapes of some of the insobars in high latitudes (being undulations of pressure which are followed by the wind arrows) illustrate for the navigator the changes of barometer and wind which he so frequently experiences in these latitudes. The chart of the first shows the ridge of a wave near Iceland, whilst on the second its ridge was North of the British Islands, having passed to the eastward at a rate of more than 20 miles an hour, and carried with it wind changes from N.W. to S. In a 'Report to the Committee on the Meteorology of the North Atlantic,' published by this office, it is shown that steamers bound to America pass through a large number of these undulations, whilst those from America experience comparatively few of them. Hence the steamer bound to the westward will have much *quicker* changes of barometer and wind than one steaming to the eastward, because the latter is to a certain extent moving with the undulations. So that in these latitudes a fast-falling barometer in a ship steaming to the westward is not so great a sign of bad weather as it is when steaming to the eastward, because in the first case the mere speed of the ship to the westward often increases the rate of fall of the barometer; whereas the speed of a ship to the eastward tends to make the barometer fall more slowly than it otherwise would do, or even to rise. It is no

* Meteorology of the North Atlantic during August, 1873, illustrating the Hurricane of that month. 1878.

uncommon thing for steamers bound to the eastward to have a rising barometer with a southerly wind, which rarely, if ever, occurs when steaming to the westward. Of course the barometers of sailing ships are similarly affected, but, as their speed is not generally so great as that of steamers, the change is not usually to the same extent."

The work mentioned (*note* p. 522) illustrates Buys Ballot's Law (p. 184). An area of high barometrical pressure 800 or 900 miles in diameter, with the Azores on its eastern margin forms a centre around which appear to revolve the smaller areas of low pressure, these areas of low pressure form the centres of the West India cyclones, and of our storms. This subject cannot be further discussed here, but in future years will gain in importance.

It will be needless to dilate on the Pilot Charts of Captain Maury, or to give the copious tables that were drawn up to illustrate these routes. They are given on the illustrative diagram of the tracks across the Atlantic, and the lines there laid down will be sufficient to show their relative position. These tracks certainly seem to us to diverge so much from any regularity of order in different months, not exhibiting any gradual change with the seasons, as might reasonably be expected, but have a general zig-zag course, at variance with the generally received laws of simplicity and order which natural phenomena, governing these courses, usually assume. This want of an apparent general law of change is doubtless owing to the imperfection of the data upon which they are based.

But as these recommendations have been followed out by a great number of vessels, chiefly the fine clippers and passenger ships between Liverpool and New York, their voyages have been discussed and tabulated by Captain Maury in his last edition, and the general *mean* result of the best six passages in each month is given in the ensuing tables.

The *computed* routes, with the probable amount of fair or head winds, gales and calms, and distances required to be sailed over in each section of the voyage are omitted. The tables of *actual* experience which follow will, it is thought, be quite sufficient to give an idea of the subject. Only the mean results are given here, not the details from which they are derived.

CROSSINGS AND TIME FROM THE ENGLISH AND ST. GEORGE'S CHANNELS TO NEW YORK.

Month.	Latitudes of crossing the meridians of																								Total Days to Port.
	Days.	15°	Days.	20°	Days.	25°	Days.	30°	Days.	35°	Days.	40°	Days.	45°	Days.	50°	Days.	55°	Days.	60°	Days.	65°	Days.	70°	Days.	
		°		°		°		°		°		°		°		°		°		°		°		°		
January	3·7	48·5	1·3	47·2	1·4	46·5	1·7	46·0	1·7	45·0	2·0	44·7	1·9	43·5	2·1	42·6	1·6	42·0	2·7	41·5	1·9	41·6	2·2	40·2	2·1	25·7
February	3·0	49·8	1·1	49·3	1·1	48·8	1·6	47·7	1·6	46·7	1·7	46·1	1·7	45·2	2·6	43·5	3·1	41·9	1·9	41·4	2·0	41·4	2·5	40·2	2·8	26·8
March	3·1	49·3	1·4	48·6	1·2	47·5	1·8	46·3	1·6	44·8	1·6	43·7	2·2	42·7	1·8	42·5	1·8	42·2	2·3	41·7	1·7	41·1	1·9	40·5	1·4	23·9
April	4·2	49·5	1·4	49·0	1·6	48·4	1·5	48·1	1·8	46·7	2·1	45·9	2·5	44·8	1·7	44·1	2·2	43·7	2·4	42·6	2·4	41·7	2·3	40·8	1·5	27·7
May.....	4·2	48·3	1·3	48·2	1·5	47·5	1·7	46·3	1·6	45·6	1·7	44·6	1·7	44·2	2·0	43·2	2·0	42·3	2·0	41·7	2·2	41·2	1·9	40·4	1·4	25·2
June	3·4	51·2	1·6	50·2	2·4	49·5	1·5	48·4	2·4	47·6	2·0	46·7	3·0	45·2	2·3	44·9	2·4	43·5	1·7	43·0	2·5	42·0	2·3	41·6	1·7	28·8
July	5·0	50·0	2·1	48·6	1·8	47·8	2·0	46·2	2·5	46·1	2·7	44·0	2·9	44·2	4·5	44·0	2·6	43·5	2·2	42·4	1·9	41·6	2·1	40 4	1·3	32·6
August	4·2	48·6	1·6	48·4	1·7	48·1	1·6	47·6	1·7	46·6	1·6	46·0	2·1	45·0	2·1	44·0	1·8	44·5	2·0	42·3	1·9	41·3	2·4	40·2	1·2	25·7
September	4·3	49·2	1·7	47·7	1·6	46·5	1·8	45·1	2·2	44·1	2·2	43·1	1·6	43·5	1·9	43·1	1·7	42·2	2·0	42·0	1·8	41·3	2·0	40·3	1·1	26·0
October	4.2	48·4	1·1	47·8	1·2	46·9	1·4	46·5	1·5	45·6	1·6	44·5	2·2	43·5	1·9	43·5	2·3	42·7	1·5	41·8	1·8	40·5	2·2	40·3	1·7	24·6
November	5·1	48·7	1·4	48·1	1·6	47·5	1·2	46·5	1 6	45·6	1·4	44·5	2·6	43·2	2·0	42·4	2·4	42·5	2·2	41·6	1·7	41·3	3·2	33·2	2·8	29·3
December	4·5	51·5	2·1	51·9	2·4	51·7	2·6	50·7	2·2	49·9	2·3	48·8	1·6	47·2	2·2	44·6	1·6	43·5	2·4	41·7	2·7	41·1	3·2	40·2	2·3	32·2

CROSSINGS AND TIME FROM NEW YORK TO THE ENGLISH AND ST. GEORGE'S CHANNELS.

Month.	Latitudes of crossing the meridians of																								Total Days to Port.
	Days.	70°	Days.	65°	Days.	60°	Days.	55°	Days.	50°	Days.	45°	Days.	40°	Days.	35°	Days.	30°	Days.	25°	Days.	20°	Days.	15°	
								°		°		°		°		°		°		°		°		°	
January	1·2	40·0	1·5	40·3	1·5	40·8	1·2	41·9	1·4	43·0	1·4	44·0	1·0	45·6	1·6	46·5	1·0	47·7	1·1	48·4	1·1	49·0	1·0	49·7	18·2
February	1·0	39·9	1·7	39·9	1.4	40·1	1·6	40·4	1·4	41·5	1·4	42·7	1·2	44·4	1·2	45·4	1·1	46·7	1·4	48·1	1·1	49·0	1·4	49·2	19·2
March	1·6	40·0	2·1	39·8	1·5	40·8	1·2	41·7	1·3	42·6	1·3	43·9	1·2	45·4	1·1	46·6	1·0	47·3	1·1	48·1	1·0	48·8	1·0	49·4	18·5
April	1·5	38·8	1·1	39·7	1·4	39·9	1·2	40·6	1·3	41·6	1·4	42·8	1·2	44·4	1·2	45·9	1·2	47·2	1·2	48·6	1·1	49·7	1·2	50·6	17.4
May	1.5	40·0	1·6	40·2	1·2	40·7	1·3	41·1	1·2	42 0	1·5	43·4	1·6	44·9	1·3	45·7	1·2	46·5	1·5	47·1	1·3	48·0	1·2	48·9	19·8
June	1·2	39·8	1·8	40·1	1·6	40·7	1·4	40·9	1·4	41·3	1·3	43·2	1·0	44·2	1·4	45·8	1·2	47·0	1·0	47·9	1·2	48·5	1·5	49·0	19·6
July	1·8	40·1	1·7	30·3	1·2	41·2	1·3	42·2	1·7	43·4	1·6	44·2	1·8	45·6	1·5	46·9	1·3	48·0	1·0	47·2	1 0	49·2	1·0	49·6	19·0
August	1·5	39·7	1·7	39·5	1·6	40·3	1·7	40·8	1·7	43·1	1·7	44·2	1·8	46·0	1·0	47·0	1·2	48 7	1·2	49·1	1·1	49·4	1·1	49·5	21·0
September	1·3	39·8	1·3	40·2	1.4	41·1	1·7	41·4	2.0	42·0	1·6	43·8	1·1	45·0	1·2	46·6	1·1	47·7	1·2	48·4	1·0	49·0	1·0	49·7	18·7
October	1·3	40·1	1·2	40·3	1·3	41·2	1·6	42·4	1·5	42·9	1·4	44·1	1·2	44·3	1·2	46·6	1·1	47·4	1·0	48·1	1·1	49·0	1·3	49·5	18 6
November	1·2	40·0	1·5	40·0	1·3	40·5	1·4	41·3	1·5	42·5	1·4	43·7	1·5	45.3	1·2	46·6	1·2	47.7	1·5	49·0	1·3	49·7	1·4	50·5	20·2
December	1·1	39·1	1·3	40·6	1·2	40·9	1·5	42·1	1·6	42·8	1·1	43·6	1·1	44·7	1·4	46·3	1·1	47·2	1·1	48·5	1·1	49·3	1·0	49·8	17·1

These two tables give the mean track and time occupied by the best *six* of each of the sailing passages discussed as proceeding from Europe to America, and from America to Europe. The ports on the European side are London, Liverpool, Havre, and a few from the Clyde, Hamburg, &c. The last column gives the total duration of the voyage, and the intermediate day columns the time occupied in sailing between the respective meridians 5° apart.

But these six best passages of course are considerably below the average length of the ordinary voyages, which may be briefly stated as follows:—

Europe to America.—January, 19 to 87 days; mean of all, 40·1 days. February, 21 to 52 days; mean, 32·5 days. March, 21¼ to 42 days; mean, 31·5 days. April, 24 to 43 days; mean, 33·7 days. May, 18 to 47 days; mean, 32·0 days. June, 29 to 54 days; mean, 36·7 days. July, 31 to 45 days; mean, 36·8 days. August, 22 to 42 days; mean, 33·1 days. September, 23 to 40 days; mean, 29·1 days. October, 18¼ to 46 days; mean, 31·0 days. November, 28 to 53 days; mean, 37.2 days. December, 27¾ to 48 days; mean, 37·6 days.

America to Europe.—January, 17 to 28 days; mean, 21·0 days. February, 16 to 28 days; mean, 22·6 days. March, 16 to 27 days; mean, 22 days. April, 15 to 28 days; mean, 22·5 days. May, 18 to 28 days; mean, 23·2 days. June, 19 to 25 days; mean, 22·5 days. July, 17 to 27 days; mean, 21·5 days. August, 21 to 28 days; mean, 24'1 days. September, 18 to 29 days; mean, 23·1 days. October, 16 to 27 days; mean, 21·9 days. November, 17 to 26 days; mean, 22·0 days. December, 15 to 28 days; mean, 21·2 days.

These figures will show with how much more certainty the eastern voyage is made with the anti-trade winds and easterly currents in its favour, than the average voyage with their adverse influences to retard and embarrass it. Upon this subject see the remarks on the atmosphere, pages 183—195, and also those by Capt. H. Toynbee (85) to (89), pages 238 to 243. The progress of storms across the Atlantic is described in (90) to (92), pp. 243 to 250.

These tables will suffice to show all that is necessary on this well-beaten track.

10.—STEAM TRACKS TO AND FROM AMERICA.

The continually increasing amount of collision, which has advanced much beyond the ratio of the use of steam, has led to many plans for averting it, but apparently without a corresponding effect in adopting them. The terrors of this danger in the open sea are manifest, and many sad examples are too well known not to induce caution—one, that of the U.S. mail-steamer *Arctic* striking the French steamer *Vesta*, near Cape Race, in Oct. 1854, led our American friends to consider whether some means could not be employed to lessen the danger. Accordingly, R. B. Forbes, Esq., of Boston, proposed one track for steamers *going to*, and another for those *coming from* America. This problem was worked out by Capt. Maury, and we give here the result in his own words:—

The shortest distance possible for a steamer between Liverpool and Sandy Hook is 3,009 miles; the average distance actually accomplished is 3,069 miles; and the distance by the middle of the lane coming is 3,038. There is also another recommendation in favour of this lane to the West, which is this: it lies along the northern edge of the Gulf Stream, where there is an eddy setting westward often at the rate of a knot an hour. On the average, I assume that the set of this eddy will amount to 12 miles a day for three days and a half, or say 40 miles. This makes the distance by the lane coming practically about 2,998 miles; or, allowing 20 miles for detour, we shall have 3,018 miles, which will shorten the average time of the passage this way three or four hours, with less risk of collision, and less danger from Cape Race by the way.

It may be urged against this lane that it cannot always be followed on account of the ice, and that, inasmuch as it crosses the Grand Banks, the steamers that ply in it may now and then run down a fishing vessel. The reply is that, as far as the fishermen are concerned, they are now liable to be run down by the steamers both going and coming. Whereas, with the lane, that liability is incident to the steamers alone that are westwardly bound, and the fishermen will have the advantage of knowing pretty nearly where the steamer will pass, and which way she will be coming. And as for its being obstructed by ice, so as to compel the steamers, as it occasionally will, especially in May or June, to turn out of it now and then, the Erie Canal, of New York, is obstructed by ice the whole of every winter, but that does not prove it to be of no value; it only shows that it, like this lane, would be of more value to commerce if it were never obstructed by ice, or anything at all.

The Grand Banks afford a pretty good landmark, which can be used in the thickest weather. Generally the water temperature is found to fall as soon as you near these Banks; it is generally a good landmark for them. The eastern edge runs North and South, and, therefore, affords an excellent correction for longitude. Having ascertained by the lead when the vessel first strikes this edge, then noting the soundings and the distance run before clearing the Grand Banks, the latitude will also be known with accuracy sufficient to enable the navigator to decide whether he be in or out of the lane, and, if out, on which side. The lane crosses the Banks near their greatest width, 275 miles. If a steamer be crossing there in a fog, and in doubt as to her position, she can judge, by their breadth and the soundings, pretty nearly as to latitude. For instance, if the breadth of the Banks, when crossed, be less than 275 miles, but the sounding not less than 40 fathoms, the vessel has crossed the Bank to the North of the lane; but if she find herself in less than 30 fathoms, then she has crossed to the South of it. Should she, however, find herself in water that suddenly shoals to less than 20 fathoms, and as suddenly deepens again, then she is near the Virgin Rocks, or the Rock and Nine-fathom Bank to the East of them, and her position is immediately known.

It should be recollected, however, that these lands are not channel-ways in which steamers must keep or be lost. Gales of wind, ice, and other things will now and then force a steamer out of them, and in such cases she

will actually be where she is now, for she will then be in no more danger than she is now; only when she gets back into the lane she will be in less.

You will doubtless observe the advantageous position of the fork to Halifax, in the lane from Europe. As this lane approaches Newfoundland, it edges off to the South in such a manner as to render it impossible for a vessel so to miss her way as to get ashore. Suppose a steamer attempting this lane to be, when she nears the Grand Banks, 100 miles out in position (a most extravagant case), and that she be out on the Newfoundland side, she would, if behaving properly, be steered parallel with the lane, and if bound to New York, she would go clear of Cape Race. But she might be bound for Halifax, and by steering West too soon, might run upon the land; but recollect that the lane to Halifax turns off *on soundings*, and a West course from where the lane from England strikes soundings on the Grand Banks will take you clear of everything. So without the most gross neglect of the lead and all the proper precautions, which it is the duty of the ship-master to take, it would seem impossible for him to run his steamer into danger here.

In the longitude of the Grand Banks, the lane to Europe is 200 miles South of the lane to America. As a rule, this lane for the eastern bound steamers can be followed always, admitting that an exception now and then in practice will make the rule general. It will be observed that this lane runs E. 15° S. from Sandy Hook to the meridian of 70°, where it takes a course E. 12° N., towards its junction with the arc of a great circle, South of the Grand Banks. Though the distance by this lane, from Sandy Hook to this junction, is a few miles longer than the direct line, yet on account of the Gulf Stream it is in *time* the shortest distance that a steamer can take. From the Capes of Delaware it is obviously the shortest. . . . .

I will close this report with a recapitulation as to distances and courses by each lane, between New York, Halifax, and Philadelphia, on one side, and Cape Clear and the Scilly Isles on the other; first begging leave to say that, according to my computation, founded on such statistics as I have touching the velocity of the Gulf Stream, if two steamers bound for Cape Clear, and of exactly equal speed, were to start from Halifax, to see which should first get into the great circle part of the lane to Europe from New York, and if one were to go strait for it by steering East, and the other were to follow the European lane from Halifax as projected on the chart, this one would reach the point of destination quite as soon as the other, the drift of the Gulf Stream compensating for the greater distance.

DISTANCE BY LANE TO AMERICA.

		By Great Circle.
From Scilly Isles to Halifax	2,351	2,305
„ „ Capes of Delaware	2,948	2,909
„ „ Sandy Hook	2,882	2,840
From Cape Clear to Halifax	2,192	2,170
„ „ Capes of Delaware	2,789	2,765
„ „ Sandy Hook	2,723	2,695
„ „ „ by actual average ..		2,754

This statement shows that by the lane to America the distance is actually shorter, both to Sandy Hook, and, we may infer also, to the Delaware, than the average distance by the present route; for the route actually pursued by the steamers now, both to Sandy Hook and the Delaware, may be considered the same from Cape Clear or the Scilly Isles, as far West as long. 70°

DISTANCE BY LANE TO EUROPE.

	To Scilly Isles.	To Cape Clear.
From Halifax	2,436	2,285
„ Capes of Delaware	3,024	2,873
„ Sandy Hook	2,980	2,829

LANE TO AMERICA.

	Course.	Distance.
From Scilly Isles to Cape Clear	W. 33°.7′ N.	159 miles.
„ Cape Clear to lat. 51°.23′, long. 15°.0′	1°.55′ N.	187 „
„ lat. 51°.23′, long. 15°.0′ to lat. 51°.16′, long. 20°.0′	2°.17′ S.	187 „
„ „ 51.16 „ 20.0 „ 50.56 „ 25.0	6.5	189 „
„ „ 50.56 „ 25.0 „ 50.23 „ 30.0	9.50	193 „
„ „ 50.23 „ 30.0 „ 49.36 „ 35.0	13.31	199 „
„ „ 49.36 „ 35.0 „ 48.33 „ 40.0	17.45	207 „
„ „ 48.33 „ 40.0 „ 47.15 „ 45.0	21.8	216 „
„ „ 47.15 „ 45·0 „ 45.38 „ 50.0	25.10	228 „
„ „ 45.38 „ 50.0 „ 45.0 „ 51.45	27.13	83 „
„ „(a)45.0 „ 51.45 „ 44.10 „ 55.0	19.45	148 „
„ „ 44.10 „ 55.0 „ 42.40 „ 60.0	22.27	236 „
„ „ 42.40 „ 60.0 „ 41.42 „ 65.0	14.34	231 „
„ „ 41.42 „ 65.0 „ 40.30 „ 70.0	17.45	236 „
„ „ 40.30 „ 70.0 Sandy Hook	0.43 S.	183 „
„ „ 40.30 „ 70.0 to Capes of Delaware	W. 22.8 S.	249 „
„ „(a)45.0 „ 51.45 to Halifax	3.53 S.	503 „

LANE TO EUROPE.

	Course.	Distance.
From Capes of Delaware to lat. 39°.40′, long. 70°.0′	E. 10°.46′ N.	236 miles.
„ Sandy Hook to lat. 39°.40′, long. 70°0′	E. 10°29′ S.	192 „
„ lat. 39°.40′, long. 70°.0′ to lat. 40°.31′, long. 65°.0′	12.24 N.	237 „
„ „ 40.31 „ 65.0 „ 41.9 „ 60.0	9.39	227 „
„ „ 41.09 „ 60.0 „ 41.33 „ 55.0	6.5	225 „
„ „ 41.33 „ 55.0 „ 41.53 „ 50.0	4.57	232 „
„ „(b)41.53 „ 50,0 „ 53.55 „ 45.0	29.6	251 „
„ „ 43.55 „ 45.0 „ 45.46 „ 40.0	27.28	241 „
„ „ 45,46 „ 40.0 „ 47.11 „ 35.0	24.4	226 „
„ „ 47.18 „ 35.0 „ 48.32 „ 30.0	20.18	212 „
„ „ 48.32 „ 30.0 „ 49.30 „ 25.0	16.21	206 „
„ „ 49.30 „ 25.0 „ 50.14 „ 20.0	12.46	199 „
„ „ 60.14 „ 20.0 „ 50.45 „ 15.0	9.17	192 „
„ „ 50.45 „ 15.0 to Cape Clear	E. 4.34 N.	189 „
„ Cape Clear to Scilly Isles	E. 27.39 S.	151 „
„(b)Halifax to lat. 43°.30′, long. 60°.0′	E. 20.7 S.	163 „
„ lat. 43°.30′, long. 60°.0′ to lat. 42°.30′, long. 55°.0′	15.17	181 „
„ „ 42.30 „ 55.0 „ 41.53 „ 50.0	9.28	225 „

The courses and distances are for the "middle" of the lanes.

Besides the detour from the great circle which a vessel from New York, Halifax, Boston, or Philadelphia, would necessarily make by following the European lane to Cape Clear, it would require an *additional* detour of only 15 miles for vessels bound into the English Channel to use it also as far as Cape Clear. This lane, therefore, will, in consequence of the favourable currents of the Gulf Stream, put a vessel into Southampton quite as soon as she could reach that port from New York or Philadelphia by the great circle route. Vessels from Halifax will have to make the greatest detour of any by adopting the lane to Europe; but for them it is less than 100 miles out of their way as they now go, and it will prolong their average passage eastwards, perhaps two or three hours. I say *perhaps*, because I am not sure but that the steamers from Halifax and New England are set back by the cold current 20 or 30 miles on the route now used for the eastern passage. The Gulf Stream, even from where they will join it by this lane, will set them forward, on an average, 40 or 50 miles at the least. It seems, therefore, that the attractions of this lane as it regards safety should more than outweigh the *probable* loss of an hour or two during the passage. When I speak of distances by the lanes, it should be recollected that the *middle* of the lane is meant, as per table of courses and distances on previous page.

Thus it appears that one lane will practically shorten the distance from Cape Clear to Sandy Hook and the Delaware by 30 miles, while the other prolongs the distance going to Europe 75 miles; which prolonged distance, when measured not by safety, but *in time* alone, the Gulf Stream, better weather, and diminished frequency of fogs, will more than compensate for. In my judgment, these lanes, if properly followed, will make the average length of passage, as determined by the mean of all for the year, probably less each way, certainly not more than an hour or two longer than it now is. Individual passages coming will, perhaps, not be made so quickly as they have been, but, on the average, trips will be shortened.

Admiral FitzRoy also devoted some attention to this subject, and it is our duty to allude to it here.

Another question appears to require notice in these pages, because it is still a "moot point" with many persons interested in navigating the Northern Atlantic. In a well-known publication, Maury particularly recommended "Lanes for steamers."

If steamers could always steer direct courses, being full-powered, and not liable to be headed off in occasional heavy seas, such an arrangement might be advantageous; but as it is otherwise, and as screw (auxiliary or mixed) ships sail while steaming, they *cannot* conveniently keep to prescribed "lanes," however desirable it might otherwise seem.

However, as the traffic increases between Europe and America, some special arrangement may be required, even more urgently than now; in which case it might perhaps be found practicable to consider an imaginary line, from lat. 50° and long. 20° to the crossing of 45° N. and 55° W., the "line of *separation*," northward of which should go all vessels bound to the westward, and South of it all those heading to the eastward.

A great safeguard would be legislative enactment against high speed during fog, heavy rain, or snow:—authorizing a *majority* of passengers to make objection; to inspect, note, and sign the log, before disembarking; and, by a quorum, to give subsequent evidence.—"Meteorological Papers," 1858.

On former pages we have given some extracts from an essay by Herr von W. von Freeden, Director of the Hamburg Meteorological Office, on the Winds, &c., along the Tracks of the North German Lloyd steamers. What is given on pages 232—238 refers to the winds; and, as an application of that investigation, we give the following from the same work.

Normal Tracks for Steamers.

We append the tables given by Herr von Freeden, for the normal tracks for each month of the year, with his remarks on the same.

It will be seen that the proposed tracks simply contain the latitude in which every tenth meridian should be crossed in the various months, as well as the true course and distance in nautical miles from one point of crossing to the next. In all cases where the routes are *variable*, 330 miles have been entered as the distance to be run, from the Needles to 10° W., and 183 miles from 70° W. to Sandy Hook. Any slight difference which may have been caused by crossing these meridians on other than the fixed latitudes of 50° and 40½° N. has been considered to be of no importance.

MONTHLY NORMAL TRACKS *for the North German Lloyd Steamers running between the Lizard and New York.*

Outward Tracks.

The Ships pass	December. Lat. N.	Dist. in Miles.	Correct Course	January. Lat. N.	Dist. in Miles.	Correct Course.	February. Lat. N.	Dist. in Miles.	Correct Course.
From the Needles.	° ′		°	°		° ′	° ′		° ′
10 W. -	49 54	330	Variable.	49 54	330	Variable.	50 0	330	Variable.
20 „ -	49 48	383	S. 89 6 W.	50 6	387	N. 88 14 W.	50 17	385	N. 87 28 W.
30 „ -	49 6	392	S. 83 51 W.	49 24	390	S. 83 49 W.	49 43	387	S. 84 58 W.
40 „ -	47 24	412	S. 75 41 W.	47 54	406	S. 77 13 W.	48 13	404	S. 77 8 W.
50 „ -	45 0	440	S. 70 52 W.	45 24	438	S. 69 59 W.	45 42	436	S. 69 45 W.
60 „ -	42 48	452	S. 73 1 W.	42 42	461	S. 69 26 W.	42 30	472	S. 65 58 W.
70 „ -	40 42	465	S. 74 17 W.	40 24	470	S. 72 55 W.	40 36	463	S. 75 45 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.

	March.			April.			May.		
10 W. -	50 12	330	Variable.	49 54	330	Variable.	50 0	330	Variable.
20 „ -	50 30	383	N. 87 18 W.	49 40	387	S. 87 56 W.	49 48	385	S. 88 13 W.
30 „ -	50 0	385	S. 85 32 W.	49 4	392	S. 84 44 W.	48 50	396	S. 81 34 W.
40 „ -	48 20	405	S. 75 42 W.	47 36	408	S. 77 33 W.	46 50	420	S. 73 24 W.
50 „ -	46 0	422	S. 70 39 W.	44 42	451	S. 67 17 W.	43 42	462	S. 66 0 W.
60 „ -	42 20	483	S. 62 55 W.	42 30	454	S. 73 5 W.	42 30	444	S. 80 40 W.
70 „ -	40 48	458	S. 78 25 W.	40 42	462	S. 76 28 W.	40 36	462	S. 75 44 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.

	June.			July.			August.		
10 W. -	50 0	330	Variable.	50 0	330	Variable.	50 0	330	Variable.
20 „ -	50 24	385	N. 86 25 W.	50 20	385	N. 87 21 W.	50 18	385	N. 87 19 W.
30 „ -	49 24	391	N. 81 10 W.	49 45	387	S. 84 48 W.	49 42	387	S. 84 40 W.
40 „ -	46 40	433	S. 67 46 W.	48 16	404	S. 77 15 W.	47 24	420	S. 70 50 W.
50 „ -	44 12	446	S. 70 38 W.	45 42	437	S. 69 23 W.	44 36	449	S. 68 3 W.
60 „ -	42 48	443	S. 79 5 W.	42 54	461	S. 68 38 W.	42 20	456	S. 72 39 W.
70 „ -	40 42	465	S. 74 17 W.	40 36	468	S. 72 52 W.	40 32	463	S. 76 30 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.	Sandy Hook.	183	Variable.

	September.			October.			November.		
				Great Circle from 50° N. 10° W. to 44° N. and 55° W.					
10 W. -	49 54	330	Variable.	50 0	330	Variable.	49 43	330	Variable.
15 „ -				50 16	193	N. 85 10 W.			
20 „ -	50 3	386	N. 88 40 W.	50 17*	182	N. 89 40 W.	49 38	390	S. 88 32 W.
25 „ -				50 16	193	S. 89 44 W.			
30 „ -	49 26	390	S. 84 33 W.	49 43	196	S. 80 2 W.	48 56	394	S. 83 52 W.
35 „ -				49 5	199	S. 79 8 W.			
40 „ -	47 52	407	S. 76 40 W.	48 13	205	S. 75 19 W.	47 15	413	S. 75 51 W.
45 „ -				47 6	213	S. 71 36 W.			
50 „ -	45 28	436	S. 70 43 W.	45 42	223	S. 67 57 W.	44 38	446	S. 69 22 W.
55 „ -				44 0	236	S. 64 20 W.			
60 „ -	42 54	457	S. 70 18 W.	42 54	231	S. 73 25 W.	41 50	468	S. 68 58 W.
65 „ -				41 48	231	S. 73 25 W.			
70 „ -	40 40	467	S. 73 20 W.	40 42†	231	S. 73 25 W.	40 30	458	S. 79 57 W.
	Sandy Hook.	183	Variable.	Sandy Hook.	18?	Variable.	Sandy Hook.	183	Variable.

* Vertex in 50° 5 N., and 18° 18 W. In 69° W.

MONTHLY NORMAL TRACKS *for the North German Lloyd Steamers running between the Lizard and New York.*

Homeward Tracks.

The Ships pass	December. Lat. N.	Dist. in Miles.	Correct Course.	January. Lat. N.	Dist. in Miles.	Correct Course.	February. Lat. N,	Dist. in Miles.	Correct Course.
From Sandy Hook.									
°	° ′		° ′	° ′		° ′	° ′		° ′
70 W. -	40 42	183	Variable.	40 30	183	Variable.	40 30	183	Variable.
60 „ -	43 0	468	N. 72 0 E.	41 50	459	N. 79 57 E.	41 48	458	N. 80 12 E.
50 „ -	46 6	466	N. 66 30 E.	44 0	458	N. 73 31 E.	44 36	468	N. 68 59 E.
40 „ -	48 32	432	N. 70 15 E.	46 48	453	N. 68 15 E.	47 18	451	N. 68 56 E.
30 „ -	50 0	402	N. 77 20 E.	49 0	423	N. 71 50 E.	49 0	413	N. 75 42 E.
20 „ -	50 30	385	N. 85 32 E.	49 48	394	N. 83 0 E.	49 36	393	N. 84 45 E.
10 „ -	50 0	385	S. 85 32 E.	49 48	387	East.	49 40	387	N. 89 25 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

	March.			April.			May.		
70 W. -	40 24	183	Variable.	40 30	183	Variable.	40 30	183	Variable.
60 „ -	41 20	440	N. 82 58 E.	41 24	456	N. 83 12 E.	41 36	457	N. 81 42 E.
50 „ -	43 6	457	N. 76 35 E.	43 6	456	N. 77 4 E.	42 30	449	N. 83 6 E.
40 „ -	45 15	449	N. 73 19 E.	45 54	460	N. 68 34 E.	45 24	465	N. 68 3 E.
30 „ -	48 54	463	N. 61 48 E.	48 12	431	N. 71 21 E.	47 48	437	N. 70 45 E.
20 „ -	50 10	397	N. 78 57 E.	49 6	400	N. 82 15 E.	49 24	408	N. 76 24 E.
10 „ -	50 0	385	S. 88 31 E.	49 36	365	N. 85 36 E.	49 48	390	N. 86 28 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

	June.			July.			August.		
70 W. -	40 30	183	Variable.	40 36	183	Variable.	40 32	183	Variable.
60 „ -	41 36	457	N. 81 42 E.	42 0	459	N. 79 27 E.	41 34	457	N. 82 12 E.
50 „ -	42 42	450	N. 81 34 E.	43 48	452	N. 76 11 E.	43 15	454	N. 77 9 E.
40 „ -	46 6	475	N. 64 32 E.	46 48	459	N. 66 54 E.	46 24	466	N. 66 3 E.
30 „ -	48 40	434	N. 69 14 E.	49 0	423	N. 71 50 E.	49 15	436	N. 66 59 E.
20 „ -	49 48	398	N. 80 9 E.	49 54	394	N. 82 7 E.	49 54	391	N. 84 16 E.
10 „ -	49 48	387	East.	49 54	386	East.	49 50	381	S. 89 24 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

	September.			October.			November.		
				Great circle from 41° N. 65° W. to 49° 50′ N. and 10° W.					
70 W. -	40 30	183	Variable.	40 30	183	Variable.	40 30	183	Variable.
65 „ -				41 0	229	N. 82 29 E.			
60 „ -	42 6	461	N. 77 58 E.	43 12	259	N. 59 23 E.	42 50	470	N. 72 39 E.
55 „ -				45 3	242	N. 62 46 E.			
50 „ -	43 50	451	N. 76 40 E.	46 34	228	N. 66 19 E.	45 40	462	N. 68 25 E.
45 „ -				47 49	217	N. 69 58 E.			
40 „ -	46 20	449	N. 70 30 E.	48 47	208	N. 73 38 E.	48 20	439	N. 68 38 E.
35 „ -				49 31	201	N. 77 24 E.			
30 „ -	48 30	426	N. 72 14 E.	50 1	196	N. 81 12 E.	49 40	401	N. 78 30 E.
25 „ -				50 18	194	N. 85 5 E.			
20 „ -	49 30	399	N. 81 20 E.	50 21*	188	N. 88 52 E.	50 20	388	N. 84 5 E.
15 „ -				50 12	192	S. 87 15 E.			
10 „ -	49 45	338	N. 87 47 E.	49 50	194	S. 83 25 E.	50 0	385	S. 87 1 E.
	The Needles.	330	Variable.	The Needles.	330	Variable.	The Needles.	330	Variable.

* Vertex in 50° 21′ 7″ N.; 21° 3′ 8″ W.

11.—ROUTES BETWEEN NORTHERN EUROPE AND THE UNITED STATES.

Get your offing, and proceed as though you were bound to Rio, until you get into the N.E. trades. Then steer West until you fall in with the track of homeward-bound Rio traders, and then take that.

Shipmasters, bound as above, should study the trade-wind chart carefully, in order to ascertain the extreme northern parallel near which they may rely upon finding the N.E. trades. The limits of these for the month should then be marked on the chart for every-day reference and use. Having reached the mean polar limits for the month, it will, as a rule, be wise to go 2° or 3° farther South, in order to be sure of a good time in "running down the trades."

Having reached the parallel of 30°, between 20° and 25° W., the best course is still a little to the West of South, until the parallel of 20° N. be reached. Do not care to make more than 5° of westing between these two parallels. From 30° N. to 20° N. by this route, the average time will be six days in fall and winter; five in spring and summer; thus putting you fairly within the trades in eighteen days, on the average, from the Channel. It will be less from Lisbon, the ports of Spain, and Gibraltar.

Now, suppose you enter the trades at a mean between the meridians of 25° and 30° near the parallel of 20°; you should then "run them down" on that parallel to 60° W. It will take two weeks to do this; total, so far, from the Channel, 32 days. Arrived here, you are in the fairway of homeward-bound Indiamen and Rio traders; and from this point every navigator knows the way to his port. If it be on the Atlantic, South of the Chesapeake, 10 days, on the average, will put him into it—total, 42 days from the chops of the channel, and from Liverpool a day or two more, from Spain and Portugal a day or two less, to our Atlantic ports. By this route Savannah is brought nearer than Charleston; and Fernandina, made for the voyage *from* Europe, our nearest southern port. If, on the contrary, he be bound into the Gulf, it will take him 15 days, from the homeward-bound Rio track to put him into New Orleans or Mobile—total to Gulf ports 47 days. These times are for ordinary sailers. A smart ship, with a smart captain, will always make the run in less time.

This is a mere general sketch of the average route. Clever navigators will know from the charts how to vary it according to the season, and smart ships will gain upon the time, especially in reaching and "running down the trades."

The sketch supposes the ship to enter the trades near the intersection of the meridian of 25° with the parallel of 20° N. There is no particular advantage in entering the trades either on that meridian or upon that parallel, or of entering them at all, if you happen to find good winds before you get to the trades.

Thus, suppose a vessel to be off the Lizard, bound to Charleston, and that she have a 7 or 8 knot breeze that will enable her to lay up direct for port; why should she, as long as that wind lasts, run out of her way to find one that will not enable her to do any better? On the contrary, let her take ad-

vantage of it to make westing as fast as possible, and when it grows lighter or becomes adverse, as it will, then let her master stick her away South in search of a better wind.

By doing this, the voyage, as I have sketched it, may be considerably shortened. The trade-wind chart will show the navigator exactly how far South he ought to go to look for the trades in each month. A reference to this, with the injunction to make the most of a good wind wherever he finds it, seems to be almost the only sailing directions that are required for the ports above named, especially in winter and spring.

In the fall of 1856, Capt. Macloon, of the *Georgia*, asked to have pointed out to him a better route from Liverpool to Savannah, stating that he had tried three, and had had by them two passages of 60 days each, and one of 54. The reply was, in substance :—

"You ask for a new way to come from Liverpool to Savannah. I have often thought that if I were in that trade, considering the passage is a long and tedious one, I should try it on the trades; that is, when you come out of Liverpool, proceed as if you were going to cross the Line (for which you will find sailing directions at page 460 *et seq* of this work). Aim to cross the parallel of 30° N. in about 25° W., and then steer S.W. till you get well into the trades, even if you have to go as far as the parallel of 20° N. Now steer West till you get about the meridian of 60°, and then haul up for your port. If you have a smart ship, and will try this passage next November, you will make something like this run: From Liverpool to the parallel of 30° N., 14 days; thence into the trades, say 22°—20°, 5 days; thence to the meridian of 60°, 10 days; thence to Savannah, 7 days; total, 36 days.

"Within that time this passage *can* be made by this route; but as I suppose the *Georgia* is not a clipper, I will give you a week longer, or 43 days; and if you do not make it in that time, I shall be disappointed.

"M. F. Maury."

From June to October, inclusive, there is not much choice of routes. On the one hand the N.E. trades are uncertain at that season of the year—the hurricane season; while to the North calms are most prevalent, and gales less frequent. During these months therefore, the best route is the straight course, for the Atlantic ports especially, taking advantage of the winds as they present themselves, for they are too unstable for one to go either to the North or South to look for them.

At this season of the year the calm belt of Cancer is far North, and vessels that attempt to make westing between 28° and 34°, will find the winds more baffling than they will either to the North or the South of those parallels. I caution navigators to avoid the belt between these parallels as much as possible; and when they *have* to cross it, I advise them to cross it nearly on a meridian. The trade-wind chart shows the position of this calm belt for each month.

Transient vessels, bound into Philadelphia and New York, would find the southern route, in the winter months, the most desirable on account of the weather, but the passage by it would, at that the most favourable season

for it, be prolonged about a week on the average. The mistake that has been generally made by vessels taking the southern route is in their not going far enough South to get well into the trades. The trade wind chart will leave no one in doubt upon that point, and no vessel attempting the southern route should think of steering North, whatever be her port, until she falls into the great track followed by the homeward-bound vessels from the other hemisphere. They cross 25° N. in about 65° W.

Dull-sailing passenger ships from the North of Europe would do well, especially from December to March, inclusive, by taking the southern route, even though they be bound to New York. If they cannot gain time by this route, they will gain at least smooth water and pleasant weather until they reach the offings of our own coasts.

In summer, the great circle route is the best to all the Atlantic ports. Even for the Gulf ports and Cuba the route in summer time should be decided upon according to the wind one meets with while gaining an offing from Europe, rather than by considerations growing out of any fancied preference as to winds by the way. If they be such as to force you to the South, make as much westing as you can before crossing the parallel of 38°. Having crossed that parallel, it is then advisable to go South in search of the N.E. trades to carry you into the Gulf.

The reason why the North or great circle route is recommended to vessels bound into any of the Atlantic ports during the summer and fall months, from May to October, inclusive; the reason why no preference is given to the southern route over the great circle during that period, even for gulf-bound vessels; and the reason why such decided preference is given to the southern route, from December to March, may be gathered from a little reflection as to the course of the trade winds and a careful consideration.

From December to March gales of wind are most frequent along the northern route. These are mostly from the westward. This circumstance, therefore, is against the great circle route in the winter time. But from May to October the case is different. The gales along the great circle are much less prevalent.

On the other hand, the trade winds being a flow of air from colder to warmer latitudes, the difference of the temperature between the calms of Cancer, from which, and the calm belt of the Equator, into which the trade winds flow, is greater in the winter than in the summer time; consequently the more rapid, constant, and steady in the winter flow.

In the summer, however, the air in the calm belt of Cancer, though it be as far North as 35°, attains as high a temperature, especially on the continents of Africa and America, as it does in the belt of equatorial calms. Then why should not the air flow towards those continental heated places as well as to the Equator? It does; and thus the trade winds are frequently broken up in the summer time, and therefore they cannot be relied on as in winter. There is another reason why the winter trades should be fresher, more steady, and constant than the summer trades, and it is this: In the winter time the calm belt of Cancer, out of which the trade winds flow, is some 500 or 600 miles nearer than it is in the summer time to the equatorial calm belt into which the trade winds blow—the places of high and low barometer are then closer to each other; and no one engaged in

the business of commerce need be told that the closer the places of demand and supply be together the more certain and steady will be the supply.

And there is also another reason why the southern route, even by the gulf-bound ships, should be abandoned, and why the great circle route should be preferred in the summer time, which is this:—From July to October the hurricane season rages in the West Indies, while from June to October the gale charts show the great circle route to be the least stormy.

The remarks about the southern route, for vessels bound in winter as far North as the Chesapeake and New York, are intended especially for the passenger ships from Bremen, Hamburg, and other ports in the North of Europe, and they are earnestly commended to the attention of the masters of such ships.—*Maury.*

12.—FROM THE UNITED STATES TO THE EQUATOR.

In a previous section (pp. 460—484) the passage from Europe to southern latitudes was discussed, and it was there shown that a more *westerly* crossing than has heretofore been usual has been attended with great advantage. To those pages we therefore refer the reader, for the arguments which equally apply to the voyage from the western side of the Atlantic.

One of the great results of Captain Maury's inquiries was the improvement of this route; and before such a mass of evidence had been collected he recommended the great circle route to the longitude of 31° West on the Equator, as has been alluded to on page 478. This route, considered in connection with the direction of the winds and currents, is that which would naturally be chosen, if the crossing in that longitude would be considered to be a safe one to guard against being drifted to leeward of Cape St. Roque. Later experience has shown this fear to be fallaceous in a great measure, and that it seldom occurs that vessels get into difficulties here.

Capt. Maury devotes 220 pages of closely printed matter to this question; but, as his results will answer our purpose as well, we will briefly select the prominent points elicited:—

Off St. Roque, in Brasil, the tracks of all vessels bound out of the North Atlantic Ocean into the southern hemisphere fall in with each other. This is the great passway between the North Atlantic and the other great oceans of the world. Here the tracks of vessels, both from Europe and America, come together, whether their destination be around either Cape Horn or the Cape of Good Hope. Passing the offings of this great promontory of Brasil, the highway then forks. All vessels for India, China, or Australia, hugging the wind, turn off to the East; those that are bound around Cape Horn keep strait on; while those that are bound to the La Plata, to Rio, or any of the South American ports, being restricted in their courses by the winds on one hand and the land on the other, make the best of their way South, and turn off to the right as they reach the proper parallel. For these last, no further sailing directions are required after passing St. Roque. Their way is plain.

The following Time Table, by the new route, the old, and the middle, is derived from the logs of 1,160 voyages, and it therefore may be held to embody the experience of 1,160 navigators touching the best route hence to the "fairway of St. Roque." The meaning of this table is so plain that analysis and discussion can add but little to the force of its own silent story. This table shows, for each month, the average time from port to 30° N.; the place of crossing that parallel, and the time thence to the Equator, and the place of crossing it, also by each of the three routes. It shows, also, the distance from 30° N. to the Equator, and the average number of miles "made good" daily for so much of each route as is included between these parallels.

Time Table by the Different Routes.

	LONG. OF CROSSING—		DAYS FROM—		Distance from 30° N. to Line.	
	30° N.	Line.	Port to 30° N.	30° N. to Line.		
	Longitude. °	*Longitude.* °	*Days.*	*Days.*	*Total miles.*	*Average per day.*
December....Old Route	32·2 W.	25·5 W.	18·9	20·4	1835 equal	89
„ Middle „	36·6	29·1	12 5	20·5	1860 „	90
„ New „	44·7	31·5	10·8	15·0	1965 „	131
January.....Old „	34·3	24·4	17·1	17·4	1885 „	108
„ Middle „	34·5	28·1	16·2	14·9	1830 „	125
„ New „	43·2	30·	10·9	14·3	1960 „	137
February ....Old „	29·5	22·6	16·6	23·2	1835 „	79
„ Middle „	35·1	25·6	15·7	14·6	1870 „	128
„ New „	42·5	30·2	11·8	14·3	1940 „	135
March .....Old „	31·2	23·7	16·4	20·9	1860 „	89
„ Middle „	33·	28·2	14·2	17·2	1820 „	106
„ New „	42·5	29·	11·5	16·3	1970 „	121
April .....Old „	32·4	25·6	17·2	18·1	1835 „	101
„ Middle „	33.2	28·1	16·7	17·2	1825 „	106
„ New „	40·6	29·9	13·7	15·8	1910 „	121
May .....Old „	33·	24·	22·8	19·4	1865 „	86
„ Middle „	36·4	29·1	19·5	20·2	1855 „	92
„ New „	41·2	31·	12·9	16·5	1890 „	114
June .....Old „	32.7	26·4	21·1	23·6	1830 „	71
„ Middle „	39·5	28·2	17·6	21·4	1920 „	90
„ New „	43·5	30·7	13 8	21.2	1945 „	92
July .....Old „	31·6	24·2	24·6	20·3	1850 „	91
„ Middle „	42·1	27·7	15·1	24·4	1990 „	82
„ New „	45·2	30·5	13·	20·5	2000 „	97
August .....Old „	31·6	25·3	22·	22·	1830 „	83
„ Middle „	41·4	26·7	16·	22·2	2000 „	90
„ New „	45·7	30·4	14·2	24·4	2010 „	82
September....Old „	33·8	25·2	19·3	23·0	1867 „	81
„ Middle „	38·8	29·	16 8	25·6	1880 „	73
„ New „	41·7	31·5	15·8	16·4	1890 „	115
October .....Old „	28·9	26·7	19·	20·7	1810 „	87
„ Middle „	33·	29·5	16·	20·	1815 „	90
„ New „	43·	31·7	12·6	21·9	1930 „	88
November ....Old „	32·	25·8	17·7	18·9	1830 „	97
„ Middle „	34·4	28·9	20·2	18·8	1825 „	94
„ New „	42·5	30·7	11·8	18·7	1940 „	104

The daily distances give to the navigator practically the best idea possible as to the difference in the winds by these several routes as they cross the N.E. trade wind belt, supposing that belt to lie all the year round between the Equator and the parallel of 30° N. Thus, in some months, as in October, for instance, there appears to be practically no difference in the winds, the average rate of sailing being 87 miles per day by the old route, 88 by the new, and 90 by the middle—a difference purely accidental, for the N.E. trades are, at this season, pretty nearly broken up. The gain by the new route, for this month, is not in crossing the trade wind belt, but in reaching it. It takes, from our Atlantic ports, 12·6 days to reach it by the new route, 19 by the old, and 16 by the middle; and having crossed 30° N., the trade winds thence to the Equator, at this season, are the same for all routes. Not so at other seasons.

From 30° N. to the line, the average distance sailed daily during the winter months is 92 miles by the old route against 134 by the new. To what is this difference owing? Are the ships that take the new route the faster? That can hardly be. They are better navigated I have no doubt, for, as a rule, the log-books show that. But still that is not sufficient to account for all this difference. In winter, a ship that takes the new route from 30° to the line will go nearly as far, on the average, in one day as she could go in a day and a half by the old route. This is owing, in a great measure, to the fact that the new route lies through a region of the ocean where the breezes are brisk, and brisk breezes always help to make both officers and crew brisk. This great difference of time and speed is probably owing to this circumstance more than to any other.

SECTION IV.

PARTICULAR DESCRIPTIONS OF THE COASTS AND ISLANDS OF THE NORTH ATLANTIC; WITH DIRECTIONS FOR SAILING AMONG THE ATLANTIC ISLES.

☞ The BEARINGS and COURSES are those by COMPASS, unless where otherwise expressed; but those given thus [*W.S.W.*] signify the TRUE; and the given direction of Wind, Tide, and Current is to be considered as the TRUE.

1.—ENGLAND, IRELAND, FRANCE, SPAIN, AND PORTUGAL.

It would be beyond the limits and scope of the present work to enter into the minute description and directions for the extensive line of coast of north-western Europe, as would be sufficient guide to the mariner; such details must be sought for in the special Sailing Directions which accompany each chart, and where all necessary instructions are given.

This book being specially concerned with the general navigation and phenomena of the ocean, only those more prominent features sought for in an over-sea voyage in the more frequented coasts, or those which may not be given in any other of our publications are here alluded to. The lighthouses are amply described in the lists in the preceding part of the volume.

THE ENGLISH CHANNEL is amply described in our Sailing Directions for the same, and on pages 448 to 452, *ante*, are given some useful remarks as to its general navigation, with which most sailors are well acquainted. In passing from the Strait of Dover westward, the first place where shelter may be found on the English coast is Dungeness Bay.

Dungeness lies 20 miles W.S.W. ½ W. from the South Foreland, and 13 miles S.W. by W. ¾ W. from Folkestone. It forms a remarkable shingle point, projecting in a S.S.E. direction 4 miles beyond the fair line of the coast, affording shelter in the East Bay from North round westerly to East, or for nineteen points of the compass. If there is any southing of East in the wind there is no shelter in either bay. The bottom in both bays is fine sand over clay and mud, and excellent holding ground throughout.

On Dungeness two lights are shown, a second light at the extremity of the point having been found necessary on account of the rapid increase of the

shingle. This outer light is S.S.E. ½ E., 225 yards from the main lighthouse, and shows a bright *flash* every 5 seconds. The main lighthouse is painted in red and white bands, and shows a fixed light elevated 92 feet, bright to seaward and *red* over the anchorages, in the West Bay from West to the land, and in the East Bay from N.E. by E. ½ E. to the land. A *fog-horn* is sounded, two blasts in quick succession, once in every two minutes in foggy weather.

To the W. ½ S., distant 3¼ miles from Dungeness lighthouse, lies the eastern end of a narrow ridge of sand, called *Stephenson Shoal;* it thence extends for nearly three-quarters of a mile in the same direction, and carries a depth of from 19 to 23 feet water, with 4 or 5 fathoms around it. The South Foreland and Dungeness Lights in one, lead three-quarters of a mile to the southward.

The *West Road* of Dungeness is that space between the first building to the westward of the lighthouse, and the black coastguard buildings at Jewrys Gap. It affords good shelter against north-easterly winds with the wind as far to the southward as E. by S., and is much frequented by vessels bound to the northward. The best anchorage, in about 6 fathoms, is with Romney Church tower in one with Lydd Church, and Dungeness Lighthouse E. ¼ S. Smaller vessels may run further in towards the beach, guarding always against a sudden shift of wind. The western tide runs easy, and affords a good slack for running or working in.

East Road affords good shelter to vessels of all classes in from 4 to 12 fathoms, upon pretty good holding ground with the wind between N. by E. and S.W. The best position for anchoring is, Lydd Church, just open to the northward of No. 2 Battery, and the lighthouse bearing S.W. by W. ¼ W. 7 fathoms water.

Pilots.—The pilot cutters, with London pilots on board, cruising between Dungeness and Dover, show at night two flame lights in quick succession every 15 minutes.

The Royal Sovereign Shoals are a number of rocky banks which lie directly in the track of vessels proceeding between Dungeness and Beachy Head. The principal names to them are, the Royal Sovereign, Horse of Willingdon, Elphick Tree, Rattan Shoal, Kinsman Nab, Long Shoal, and Southern Head. The *Royal Sovereign*, by far the most formidable of this group, has only 9 feet water on it, and, being 6½ miles from the point, it is very dangerous. It bears E.S.E. just 8 miles from the Beachy Head lighthouse; S.S.E. ½ E., 4⅛ miles from Langley Point; and S.E. by S. 2 miles from the Horse of Willingdon.

The *Light-vessel* marking the outer side of these shoals was placed in position in the year 1875. She is moored in 12 fathoms water, with Lighthouse Cliff just open of Beachy Head, N.W. by W. ½ W.; Royal Sovereign buoy North (westerly) distant 2 miles and Dungeness E. by N. 23½ miles. She carries a *gong* for foggy weather, and a gun to warn vessels standing into danger.

Seaford Cliff, kept in sight to the southward of the pitch of Beachy Head, will lead at least 2 miles to the southward of the Royal Sovereign Shoals. Beachy Head light, kept open of the next eastern cliff, also leads outside all

the shoals. Fairlight Mill, in a line with the N.W. part of the cliff eastward of Hastings, leads to the eastward of them.

From *Beachy Head* to the S.E. part or Elbow of the Owers (the lightvessel), the bearing and distance are W. by N. ¼ N. 12 leagues; and to St. Catherine's Point, on the same bearing, the distance is 20 leagues. From Beachy Head to Selsea Bill, the coast trends in a curve; but the direct bearing and distance are W.N.W., 13¼ leagues.

Seaford Road.—Between Shoreham and Beachy Head the depths very gradually decrease from the offing towards the land, and vessels may anchor all along the coast with off-shore winds in from 2 to 9 fathoms water; but the anchorage of most general resort is that in Seaford Road, which lies between the tide mill which stands to the eastward of Newhaven and the Martello Tower near the beach at Seaford. The best anchorage in the road is between the tower and Blatchington Battery, with Beachy Head Lighthouse just shut in by the cliffs, over a bottom of sand, shells, and mud. At this anchorage Beachy Head Cliffs will afford shelter with the wind as far southerly as E.S.E., and it is therefore superior to the western Bay of Dungeness. Seaford Head is often mistaken for Beachy Head by vessels coming up channel within 4 or 5 miles of the land; they may however be distinguished by there being a small building (the coastguard houses) on the highest part of Beachy Head, whereas there is nothing on the former but a conspicuous large green patch on the face of it.

At 9 miles westward of Seaford Roads is the town of Brighton, the lights of which are conspicuous at night, and at 8 or 9 miles beyond this is Worthing, another watering place. The coast is generally very low.

At 5 miles to the N.N.E. of Worthing is Chanctonberry ring, a large circular thick grove of trees 964 feet above the sea, and frequently the first object seen on making the land. A reference to this object would often assist the mariner when all other objects are too low or indistinct to be observed.

At 13 miles beyond Worthing is Selsea Bill, off which runs the line of shoals marked at its S.E. point by the Owers Lightvessel, showing a revolving light. These shoals are described in the Directions for the Channel.

SPITHEAD.—The limits of the best anchorage at Spithead are Southsea Castle N.E. to E. by N., and Gilkicker Point N.N.W. to N.W. A good berth for large ships is with Southsea Castle Lighthouse on with the North end of the Spit Fort N.E. by E. ½ E., and Kickergill Tower on with a red and white mark on the western end of Monkton Barracks N. by W. ¾ W. in from 10 to 12 fathoms water; but small vessels may berth themselves nearer to the Spit sand, in about 7 fathoms, care being taken not to open Kickergill Tower *from* the East end of the barracks. Vessel moored should have open hawse to the southward. The *torpedo ground* near No-mans-land Fort, and also that near Gilkicker Point is marked by green and white buoys. The space marked off by these buoys is to be avoided.

The entrance by the Needles Channel will be found in our Directions. They require too much space to be described here.

In the southern part of *Poole Bay* the ground is clear, and there is an open anchorage in 6 or 7 fathoms water, over sand and gravel, with

Studland Church bearing West 1½ miles. In the northern part of the bay, however, are several patches of dangerous rocks, with 6 and 7 fathoms between them.

PORTLAND.—The Roads of Portland lie between Weymouth and the Portland Breakwater, which abuts on to the N.E. point of the island, and runs off shore in a direct line East, by compass, for 3,500 feet; but at the distance of 2,000 feet from the shore is an opening of 400 feet wide, between two circular heads of masonry. From the eastern end it curves round to a true *North* direction for 5,600 feet, making the total length of the breakwater 3,000 yards, or nearly 1¾ miles. Its outer extremity is in 8 or 9 fathoms water, and the depth of 4 fathoms will be found 1½ miles within the pier.

A circular fort forms the end of the breakwater, and on this is shown a fixed *red* light, which is however not visible to the southward between S.S.W. and W. by S. ½ S., being obscured by Portland peninsula. It is also obscured to the westward by the Chesil Bank, to an observer 15 feet above the sea when he is within 2 or 2½ miles of it, and the light bearing between E. by N. ½ N. and E.S.E. A *bell* is sounded at the lighthouse in foggy weather. Vessels, in passing, should keep not less than a cable's length eastward of the light.

The Bill, or southernmost point of Portland, lies W. by N. 5 leagues from St. Alban's Head, and about 3½ miles to the southward of the North point of the isle. It has a white obelisk on its extremity, and half a mile within it are two white lighthouses.

At Night the leading mark between the Shambles and the Bill is the two bright fixed lights or Portland Bill in one, N.W. by N., until the fixed *red* light on the breakwater bears N. by E. ¾ E., when steer for it, taking care to keep a safe offing when approaching Grove point, and a prudent distance when passing the breakwater. During the eastern stream the higher light should be kept open to the westward of the lower one, as that stream sets with great velocity over the Shambles; and as the western stream sets as strongly into the Race, similar precautionary measures should be taken not to be set to the westward.

Shambles.—The eastern end of the Shambles, a dangerous shoal, of coarse shingle, sand, and shells, bears from St. Alban's Head, W. ¼ N. 11½ miles, and from the Bill of Portland E.S.E. 4¼ miles. The bank extends thence W. ½ N. 2 miles, and the West end lies with the Bill of Portland N.W. ½ W. 2½ miles. It is steep all round, having 14 fathoms close to it; but always shows itself by a break or ripple. On its East and West ends are from 6 to 7 fathoms; but, near the middle, are only 11 feet at low water. The shoal, in fine weather, is always distinguishable by the rippling. The tide rises over it about 10 feet perpendicular. Its eastern end is marked by a lightvessel, on which is a powerful *fog trumpet*.

TORBAY.—The entrance into the bay, formed by Hob's Nose and Berry Head, is 3½ miles wide, and the ground within is generally clear and good.

In sailing in, you may, if necessary, keep close either to Berry Head or the Orestone. To sail between the Orestone and Loadstone, keep nearly in mid-channel, taking care not to approach too near the West side of the Orestone, as the water is shoal for half a cable's length from the rock

on that side. To the S.W. by S, a little more than a cable's length from the Orestone, there is a sunken rock, with only 6 or 8 feet over it at low water.

Ships may anchor in Torbay in 6, 7, 8, and 9 fathoms; the ground is strong clay and remarkably good. The common marks for anchoring are, Berry Head South, S. by E., or S.S.E., and Brixham Church on with the pier-head. The best ground is about a mile from Brixham pier-head, in 7 fathoms of water; but ships may ride, well sheltered on the North side. A great swell is forced into the bay by easterly winds, but, about 1½ miles from Brixham pier-head, there is an underset to windward, by means of which ships ride easier than in other parts of the bay. In general, the deeper that you anchor in the bay, the better will be the riding, being more out of the stream. From the middle of the bay, in 7 fathoms, Berry Head bears S.S.E., and the Orestone E.N.E. Small vessels commonly lie aground at Brixham, on the South side, and at Torquay, on the North side, of the bay.

DARTMOUTH.—The entrance to Dartmouth Harbour lies nearly 5 miles from Berry Head, and about 7 miles to the N.E. of the Start Point. It is situated between two high lands, within which is an excellent harbour, sufficiently capacious to contain 300 sail of vessels, secure from all winds, in from 7 to 15 fathoms.

On the eastern side the Mewstone and the Outer and Inner Froward Points are outermost, within is Kingswear Castle, lately re-edified. A conspicuous octagonal *granite beacon*, 80 feet high, stands on the high land at the back of the Mewstone, elevated 500 feet above the sea, and bears from the Mewstone N. by W. ¼ W., 6 cables distant.

On the *eastern side* within the *Mewstone*, above alluded to, are the *Vertical Rocks*, so named from their high, upright sides, running parallel with the shore for a quarter of a mile to westward of it. The water is deep close to them. Beyond these are the *West Rocks*, dry at very low tides; the *Castle Ledge*, marked by a *black buoy*, 100 yards outside it, has only 8 feet over it. Battery and Kingswear Points touching N. by W. ¾ W., lead to the eastward of it, up to Castle Point. Beacon Hill in one with Kingswear Castle, and outside Inner Froward Point N.N.W. leads clear inside Old Castle Rock. The Mewstone, the Shooter, the Bear's Tail, Castle Ledge, and the Blackstone, on the western side of the entrance, all lie in one line.

The *Pin Rock*, a formidable rock of 13 feet, one-third of a mile East of the Homestone, was blasted away in June, 1865, and now lies with 5 fathoms water over it.

Ships coming in from sea, if obliged to wait for an opportunity of entering, generally anchor without, in the part called the *Range*, which has a depth of from 7 to 10 fathoms. Here they lie safely when the wind does not blow in; and when it does, it will lead into the harbour. From S.W. to E.S.E., the wind blows true in, and from N.W. to N.E. true out: all other winds blow in flaws. Pilots are always ready; a signal may, therefore, be hoisted for one when approaching the Range. A steam-tug is also established, and will always be ready.

The fairway mark leading up to Battery Point is the flagstaff of Dart-

mouth Castle in one with Sir Henry Seale's house on Mount Boone, or Battery and Kingswear Points touching N. by W. ¾ W.

The *Kingswear Lighthouse* shows a fixed light, *white* in the fairway, *green* on the West side of the fairway, and *red* on the East. Above the entrance and up to the town is also marked by a light showing white in the fairway.

To sail in for *Dartmouth* from the eastward, with a leading wind, from off the Mewstone, steer for Combe Point, until you bring Kingswear Point on with Dartmouth Castle; thence, by steering with this mark on, you will clear the eastern ledge. When nearly abreast of the Blackstone, and having left the *black buoy* off the Castle Ledge on the starboard side, keep the castle open on the port bow, until the southernmost house in Kingswear is open of Dartmouth Castle Point. This mark leads clear of the *Checkstone*, marked by a *chequered black and white buoy*, whence you may run in and anchor.

To sail in from the westward, with a leading wind, give a good berth to the *Combe Rocks*, which lie off the shore on the West side; the outer Combe dries at half ebb, and has deep water all round; then steer to the eastward, until Kingswear Castle is open to the eastward of the Blackstone. This mark kept on will carry you clear of the Homestone, which has a *black* and *white* horizontally *striped* buoy in 7 fathoms, half a cable S.E. of it, and S.W. by W. ½ W. 5¼ cables from the Castle Ledge buoy. With Stoke Church shut in, you will have passed the Homestone, and may steer for the Blackstone. Having passed the latter, keep Dartmouth Castle on the port bow, and proceed as above.

For sailing ships, great inconvenience attends the ingress to, and egress from, Dartmouth Harbour, in consequence of the frequent and violent flaws of wind, which issue very suddenly from the high lands. Therefore, no square-rigged vessel should attempt to enter or leave the harbour without a leading wind. Between S.W. by S. and S.E. by E. the winds blow truly in, and as truly out when between N.W. by N. and N.E. Even cutters cannot always succeed in getting to sea with S.W. winds. These remarks of course do not affect steamers.

Start Point may be well known from its rugged cock's-comb-like appearance; the hillocks on its side within the lighthouse are five in number, each about 200 ft. in height. Peartree Head, within the point, rises to 386 ft.

There are no dangers in the vicinity of its projecting points to the South and S.W. except the Pear Tree, the Start, and Cherrick Rocks; the latter lies S. ¾ W. upwards of 2 cable's lengths from the point, and is just awash at low water springs. A sunken rock, with only 12 ft. water over it, also lies at the same distance due East from the lighthouse; to avoid it a vessel should not shut in the village of Hall Sands with the Start Point, until the Pear Tree Rocks open out to the southward of the Start Rocks, when, by giving the latter a berth of about 2 cables' lengths, she may proceed to the westward.

A *Lighthouse* stands upon the Start at 140 yards from its extreme point; it is a stone tower 110 ft. high, exhibiting a powerful revolving light, at an elevation of 204 ft. above high water, and showing a bright *flash* every minute to seaward, till it comes to the bearing of West, on which it is eclipsed, and may be seen in clear weather at the distance of 20 miles. A *fixed* light is also shown in the same tower, 192 ft. above high water, in

the direction of Berry Head, visible only when the Start Point bears W. ¼ S. and S.W. by S., to guide vessels to Dartmouth and the Berry Head.

To the north-eastward of the Start lies a dangerous bank of pulverised shell and fine gravel, called the Skerries.

To avoid the Skerries at night, a vessel should not approach them within 20 fathoms water; and in coming from the northward, if wishing to run to the westward of them, she should keep the fixed light on a S.W. ½ S. bearing, and pass the Start at a distance of a quarter of a mile on its northern side, and half a mile on the southern side. When Start Light bears N.W. ½ W., she will be to the southward of the Skerries.

The Eddystone Lighthouse, with its fixed light, bears E. ½ S. 39 miles from the Lizard, and W.N.W. ¼ W. 18 miles from Bolt Head, near Salcombe. It is painted with a broad red stripe, which will distinguish it at once from the Bishop Rock Lighthouse.*

From the Eddystone Lighthouse, at the distance of 3½ miles, N.W., there is a bed of sunken rocks, called the *Hand Deeps*, which lie nearly in the fairway of ships bound from the westward for Plymouth Sound. They consist of rocky pinnacles, and on the shoalest part are from 22 to 24 ft. at low water spring tides. The shoal has, commonly, a ground swell on it; and with a S.W. gale and ebb tide, the sea here runs very high, so that a ship may depress (or *send*) 5 or 6 ft.

The best mark for clearing this dangerous shoal is furnished by the Breakwater lighthouse, in one with Penlee Point, E. by N. ½ N.; it leads a long mile to the northward of them, and a mile to the S.E. of them when in one with Mount Batten in Plymouth Sound, N.E. by E. ¼ E.

PLYMOUTH SOUND is the most capacious and secure harbour in South Britain. The magnificent Breakwater is 5,000 ft. long, and at its West end is the lighthouse, showing a red light seaward, and bright northward of S.W. ½ W. over the anchorage within. Below this red light is a leading bright light, visible only in the fairway of the western entrance. A large *bell* is tolled in fogs or snow storms.

On the East end of the breakwater is a beacon, a granite obelisk, surmounted by a staff and ball. This ball is so constructed that ten persons might find shelter within it should they be cast away on the breakwater. Besides these there is a look-out house or signal-station on the *Hoe*, at the head of the Sound, eastward of which is an obelisk, painted red and white.

The entrance of Plymouth Sound is distinguished on the eastern side by two remarkable large rocks, which lie upon the extremity of reefs that stretch from the shore. Of these rocks the southernmost is called the *Mewstone;* the northernmost, the *Shagstone*. The first lies nearly S.W. by S., half a mile from Wembury Point, or the S.E. point of the Sound, and has, just within it, a smaller one, called the *Little Mewstone*, from which a shoal stretches to the W.S.W. nearly 2 cables' lengths, and is marked by a red buoy at its outer extremity.

The bearing and distance from the Great Mewstone to Rame Head are N.W.

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* Caution.—The lighthouse is not considered quite safe. The rock on which it stands is being gradually undermined by the sea.

by W. ½ W. 4½ miles, and to Penlee Point N.W. by W. 3⅕ miles. The entrance of Plymouth Sound lies between the two latter, and it may, from a distance, be readily known; the land over Plymouth being high double land. On a near approach, Rame church will appear open to the northward of Rame Head, and the square tower of Penlee will be seen standing upon the highest part of the land over Penlee Point, which affords the more certain mark.

Renny Rocks appear like a black rock, lying N. by W. nearly 1 mile from the Mewstones, and at about one-eighth of a mile from shore. At the distance of a cable's length W.N.W. ¾ W. from the islet stands the *Shagstone.*

The *Tinker*, and the *Knap* and *Panther*, are well known as the principal shoals in the lower part of the Sound. Of these, the outer one is the Tinker. This shoal, which is a cable's length broad, stretches nearly one-quarter of a mile East and West, and its western extremity lies N.N.W. ½ W. more than 1½ mile from the Little Mewstone. It has on it from 10 ft. to 3½ fathoms of water. On the shoalest part of the western end, without the depth of 14 ft., there is a *white buoy.*

There is also a *white buoy* on the eastern side of the Tinker, which marks the *Eastern Channel.* With the Bolt Head open to the southward of the Mewstone, or hidden behind it, you will be well to the southward of the Knap and the Tinker.

The *Knap* and *Panther* are extremities of one rocky ledge, upon which there are 3, 3½, and 4 fathoms of water. This ledge is more than one-third of a mile in length, and extends in the direction of N.E. by E. ½ E. and S.W. by W. ½ W. Each end is distinguished by a *black buoy.*

A reef extends S.S.E. ½ E. nearly a quarter of a mile from Penlee Point, and terminates in a sunken rock of 12 ft of water, called the *Draystone.* A *chequered red and white buoy* has been placed on it. It lies in 5½ fathoms, 2 cables' lengths from the point.

The *New Rock* lies N.W. ½ W. rather more than three-quarters of a mile from the buoy of the Knap, with Maker church tower bearing N. by E. ½ E.

Western Channel.—This channel, lying to the westward of the Knap and Panther, has sufficient depth for the largest ships; and is the *principal* channel to Plymouth Sound, being the only one that can be used safely by large vessels at all times of the tide.

Ships coming in here for the Sound should, in the first instance, to clear the Draystone, as well as the Knap and the Panther, bring the breakwater lighthouse in a line with the white tower on Mount Batten. To keep to the southward of it, you keep the end of Bovisand Pier in a line with or open to the southward of the beacon on the East end of the breakwater.

The *Leading Mark* through the channel is, the breakwater lighthouse in line with the white tower on Mount Batten, at the entrance to the Catwater, bearing N.E. by E. ½ E., as above.

There is generally a good deal of sea running during the ebb tide, near the West end of the breakwater, and near the West end of the work a ship is very liable to miss stays in working out, by reason of a cross sea and an eddy tide. The ship should, therefore, be put about before getting too near to the West end of the work, in order to avoid the risk of missing stays and drifting upon it.

To sail in during the night, bring the Eddystone light S.W. ¼ W., and steer N.E. by N., or N.E. by E., according to the wind and tide, until the water shoalens to 20 fathoms, in which Penlee Point will be 1¾ mile distant; or, until you make out the breakwater light, which should be brought to bear N.E. by E. ½ E. until the white leading light in the lighthouse is seen, when the channel will be open; and keeping the white leading light in sight, run direct for it. After rounding the breakwater, haul to the north-eastward, but do not anchor till the red light has fully changed to white, which it will do when it bears S.W. ½ W. The water shoalens to 9 or 10 fathoms, about three-quarters of a mile from Penlee Point; this side being the safest to run in by in the night, or in thick weather. Be careful to go no nearer to the point than in 9 fathoms, as this depth is but little more than half a mile from shore. With the point W.N.W. you will be above the danger, and may then steer for Cawsand Bay, according to circumstances.

The Eastern Channel into Plymouth Sound should not be attempted by vessels of any considerable draught of water, unless with a free wind, because of the numerous rocks which are scattered in its vicinity, and the occasional send or depression of the sea there, with south-westerly and south-easterly winds. The mark for this Channel is, to bring the beacon on the eastern end of the breakwater in one with the striped obelisk on the Hoe bearing N. by E. ¾ E., which will lead between the Tinker and the Shagstone.

In the centre of the fairway, however, are three rocky patches, of 24 and 18 ft. water, at low water springs, the eastern extremities of which rather encroach upon this line of direction; two of these lie nearly half a mile to the southward of the Breakwater, and are marked by black and white chequered buoys; the Tinker by *white* buoys; and the shoal bank (which extends from the eastern shore and the Shagstone) by two red buoys. The above mark will lead up to the East end of the breakwater, leaving the red buoys to starboard, and the chequered to port. The breakwater may be rounded for the anchorage at the distance of 60 or 80 fathoms, leaving the Leek Bed and Duke Rock to the northward.

The Eastern Channel is perfectly safe, and always desirable with a leading wind and smooth water; for this reason it is much frequented in easterly winds. It is not, however, desirable to beat through this channel, unless in small vessels, in charge of persons well acquainted with the locality, for there is no anchoring ground in the channel.

FALMOUTH.— From Rame Head to St. Anthony's Point the bearing and distance is W. ¼ N. 32 miles. The harbour of Falmouth is one of the best in England. Its advantages arise partly from its peculiar situation, and partly from the influx of several rivers. The entrance is formed by the bold rocky coast of St. Anthony's Head on the East, on which is the *revolving light*, and by the headland called Pendennis Point on the West, distinguished by Pendennis Castle, which stands over it, on the summit of a hill. A lower *fixed light* is shown between S. by W. ¼ W. and S.S.W. ½ W., below the revolving light, and vessels by night must not lose sight of this in passing the Manacles. From the Point of St. Anthony to that of Pendennis the bearing is N.W. by W., distance exactly 1 mile.

Within St. Anthony's Head, on the East side, are the castle and town of

St. Mawes, which stand on the North side of St. Mawes' Creek, or the entrance of the River Penkule; and within Pendennis Castle, to the N.W., stands the town of Falmouth.

On the North side of the Pendennis Peninsula is a fine range of docks, with the necessary graving docks and other appliances, fitting it for an important packet station, in connection with the Great Western Railway.

In the entrance of the harbour, at the distance of one-third of a mile to the S.E. by E. of Pendennis Castle, and E. by S. from Pendennis Point, is the *Black Rock*, which is uncovered, in spring tides, from 2¼ hours' ebb to 3½ hours' flood. There is a *beacon* on it (a cone with mast and ball), which sufficiently indicates its situation. Without this rock, at the distance of about a cable's length, S.E., is a rocky shoal of 16 ft. of water. Between this shoal and some rocks which lie off St. Anthony's Head, is the usual entrance into the harbour.

Without the entrance of the harbour is the *Outer Anchorage*, or what may be more properly called *Falmouth Outer Road*, from St. Anthony's Point toward the Manacle Rocks. Here there is good anchorage with the harbour's mouth open, equal in point of riding to Mevagizey Bay, superior to Cawsand Bay, and very little inferior to Torbay, with the wind from S.W. round to the westward, and northward to the N.E. point of the compass. The best position is in 12 fathoms, a mile South of Pendennis Castle, with Badock Church on the high land in line with the middle sandy beach of Swanpool N.W. by N. ¼ N., and Pennare Head open to Killygerran Head E.N.E. In taking this anchorage care should be taken to avoid the *Old Wall*, a rocky shoal, lying South by compass, 1¼ mile from St. Anthony's Point. It is a small pinnacle rock, with no more than 26½ feet of water on it. The marks for it are the Restronguet smelting-chimney up the creek in line with the eastern end of the broken rocks off St. Anthony's Point N. ½ W., and the Greeb Point next North of Killygerran Head showing East of the latter, N.E.

Within the Old Wall for 4 cables' lengths there is a depth of 8 and 9 fathoms, but between that and the point the depths are very irregular from 27 feet and upwards.

A vessel from the westward bound to Falmouth by night should keep the Lizard lights in sight to the southward of the Beast until St. Anthony lower fixed light comes in sight, which is shaded over the Manacles on the bearing of S.S.W. ½ W., and leads 2 cables East of a *bell buoy* on their eastern side.

In the daytime the Beast should be kept open of Black Head; and when St. Anthony lighthouse bears N.N.E., keep it on that bearing till Killigannoon house is in one with Penarrow or Mylor Point, bearing N. ¼ E. easterly, which will lead in through the eastern channel, and through the narrows into Carrick Road, where a vessel may anchor in from 12 to 18 fathoms, or proceed on until Budoc Church comes over the rising ground of Trefusis Point, or the summer house is in one with Falmouth Church bearing W. by S., which will lead through the Cross Road, till St. Keverne Church comes over Pendennis Point, bearing S.W.; with which mark she may anchor in St. Just Pool in from 12 to 15 fathoms, over a muddy bottom.

In hazy weather, a vessel should give St. Anthony Point a berth of 2 or 3

cables' lengths, and run in with the land of St. Mawes about a point on the starboard bow, and then steer for Penarrow Point. She should not approach the land of St. Mawes nearer than 2 cables' lengths, nor St. Mawes Bank within 9 or 8 fathoms. With the wind at East she will sail in free on the starboard tack, and at W.N.W. on the port tack.

Western Channel.—Vessels not drawing more than 18 feet may safely pass between the Black Rock and Pendennis Point, and at half tide there is water for ships of the line. By taking the centre of the channel, and steering a N. by E. course, it will lead up between the buoys in the narrows; or when the Black Rock beacon and lighthouse are in one, steer for St. Mawes Castle until Killigannoon House comes on with Penarrow Point, bearing N. ¼ E., and proceed as before.

THE LIZARD.—The Lizard is a bold land, which lies 5 miles W. by S. from Blackhead, and W. ¼ N. 12¾ leagues from the Eddystone. It may be seen 7 or 8 leagues off, in from 40 to 42 fathoms of water, and may be readily known by the two lighthouses which are erected upon it. These lighthouses, with *fixed* lights, when in a line, bear W. by N. and E. by S., 222 feet from each other, and may be seen 6 or 7 leagues off. The towers, each 61 ft. high, are white, the East light being elevated 229 ft., and West light 232 ft. A powerful *fog trumpet* is established here, giving one blast once in every five minutes. There is also a *Signal Station.*

This headland is one of the most noted among English navigators, as it is from hence that ships take their departure from the English Channel; and it is also the best place for a landfall, when homeward bound. The position of the high lighthouse, according to the grand trigonometrical survey, is lat. 49° 57′ 34″, and long. from Greenwich 5° 12′ 4″ W.

MOUNT'S BAY.—This spacious bay lies to the N.W. of the Lizard, and is particularly distinguished by the high island called St. Michael's Mount.

St. Michael's Mount, which gives name to Mount's Bay, is a remarkable and picturesque isle, near the village of Marazion, 14 miles N.N.W. ¼ W. from the Lizard Point, and 2 miles E.S.E. from Penzance Pier. On its summit is a church and residence. At the bottom on the N.E. side is a small harbour. At low water there is a dry passage to the isle from the main land.

At about 4 miles from the Lizard, and at a small distance from shore, lies a remarkable cragged rock, called the *Gull Rock;* ships bound up Channel, if opposed by an easterly or S.E. wind, may run in on the North side of this rock, and here find shelter, near the shore, in 8 fathoms of water; but great care must be exercised in order to guard against a sudden shift of wind.

On the West side of the bay there is tolerable riding in Guavas Lake, near Newlyn, with westerly and southerly winds; but near this place are two sunken rocks, called the *Lowlee* (marked by a red buoy) and the *Carn Base.* The first, which has only 5 ft. over it, lies about one-quarter of a mile from Penlee Point, with the church of St. Paul, bearing W. by N. ½ N. The latter has 4 ft. over it, and lies about one-quarter of a mile North from the former, with St. Paul's Church on with a long hedge, appearing end on, about half-way between Penlee Point and Newlyn, and bearing W. by N. Between these rocks there is a depth of 10 fathoms.

In the winter season the anchorage in Guavas Lake ought not to be re-

sorted to but as a preliminary to entering the pier of Penzance, or that of Mount St. Michael. In approaching the shore from the offing between the Lizard and Land's End, the depths of water will be gradually found to diminish, and the bottom is mostly of coarse sand, interspersed with whole and broken shells.

Near the shore, between Mount's Bay and the Land's End, there are several dangerous rock. The first is the *Rundlestone*, a small rock, about 4 yards long and 2 broad, the base of which is dry at low water, and covered before half flood. It has a fine conical stone beacon on it. From this beacon the lighthouse on the Longships, hereafter noticed, bears N.N.W., distant nearly 4 miles; the flagstaff on Point Tol-Peden-Penwith N. 4° E., three-quarters of a mile; with the point distant a quarter of a mile. The ground without the Rundlestone is clear, but there are rocks and foul ground to the eastward and northward of it; therefore a passage within it cannot be recommended to strangers. A *black bell buoy* lies S.W. 1½ cable from it, and by night Longships red light covers the rocks.

The Wolf Rock Lighthouse bears from the Land's End, or the western-most point of land, S.W. ½ W. 8¼ miles. Between the Rundlestone and this rock there are from 20 to 36 fathoms of water. It is steep on all sides, and has within a cable's length of it from 30 to 40 fathoms all round. The lighthouse was completed at the end of 1869, is of gray granite, 143 feet high, and at an elevation of 110 feet shows a first-order dioptric light, which revolves every half minute, showing alternately a *bright* and a *red* flash of equal power at an elevation of 110 feet, visible 16 miles. A *fog-bell* is sounded in foggy weather, three times in quick succession, every quarter of a minute.

Longships.—About 3 miles N.N.W. ½ W. from Tol-Peden-Penwith, or the S.E. point of the Land's End, and 1 mile W.N.W. from the western-most point, lie the high rocks called the *Longships;* which extend in a North and South direction, about half a mile. On the largest of these rocks stands a granite lighthouse, from which a fixed light is shown, *bright* to the westward between N.N.E. ½ E. and S. by E.; to the eastward of these bearings the light appears *red*. When approaching from the northward, by keeping in the bright light, you will pass half a mile westward of the Brisons; and approaching from the southward, three-quarters of a mile westward of the Rundlestone.

LAND'S END may be seen in clear weather 8 or 9 leagues off. When first seen at a distance it appears in two round hummocks, on the highest of which is a spire steeple, the base of which is 409 ft. above the sea; upon a nearer approach, on the outermost point another spire will appear. By these objects the Land's End may be readily known; but at all times the Longships lighthouse will indicate its situation.

Cape Cornwall lies N.N.E. ¾ E. about 3½ miles from the Land's End. In the bay between, called *Whitesand Bay*, which lies about a mile to the northward of the latter, vessels may ride in from 19 to 25 fathoms, well sheltered from E.N.E. and easterly to S.S.E. winds; but the danger arising from westerly winds make it little frequented. The South side of the bay is formed by Peddenmeandue Point, from which the ground is foul and rocky to half a mile N.W.

The SCILLY ISLANDS consist of a great many small isles, islets, and rocks above water, surrounded by innumerable rocks and ledges, some of which appear at half tide, others at low water, and the greater part not at all. Many have 6, 5, and 4 ft. on them at low water spring tides. The channels or passages into the harbours are called *Sounds*. They are dangerous, but well known to the fishermen of the islands, who act as pilots. With an easterly wind, a number of pilot boats are on the lookout for vessels from the westward.

St. Agnes, which is also called the *Lighthouse Island*, lies nearly 1½ mile to the S.W. of St. Mary's. It is the southernmost of the Scilly Islands, exclusive of a group of large rocks, which cannot properly be called islands. Shipwrecks have been too frequent about these islands.

The Lighthouse stands on the most elevated ground; it is 53 ft. high, and, being painted white, is a useful daymark to all ships coming from the southward. The light revolves every minute and in clear weather may be seen at more than 5 leagues off; the lantern being 138 ft. above high water mark.

From the lighthouse of St. Agnes, the Lizard bears E.S.E., distant 14½ leagues; the Longships lighthouse E. ¼ S., distant 8 leagues; and the Wolf Rock lighthouse E.S.E. ½ E., 6¾ leagues.

The S.W. Dangers of Scilly are those called the *Bishop and Clerks*, composed of a high rock, called the *Bishop*, on which is a lighthouse, and of several ledges to the South and East. The *Bishop's Ridge*, having a race upon it, lies nearly a mile to the South of the Bishop, with the lighthouse on St. Agnes bearing East, 4 miles distant.

BISHOP ROCK LIGHTHOUSE is one of the most important structures in the English lighthouse system. It is a noble granite tower, and shows a brilliant fixed light at 110 ft. above high water.

It is placed to the S.W. of all the dangers around the Scilly Isles, and renders the approach to them comparatively easy, as it is almost the only dangerous quarter from which to make them.

The great importance of the Scilly Islands arises from their advantageous situation, as looking equally into the St. George's Channel and into the English Channel. From this reason many ships, when the wind is favourable, in coming in from the S.W., endeavour to make these islands, in order to steer their course with greater certainty. It is also sometimes convenient for vessels to take shelter among them rather than beat about at sea in bad weather, and a strong gale at East will be frequently the means of bringing in numerous vessels. Upon firing a gun, and making a waft, a boat immediately puts off from the nearest island with pilots.

In coming from the southward you will descry Scilly, in clear weather, at the distance of 6 or 7 leagues, and have 60 fathoms, with gray sand, broken shells; you may also see the land from the southward, in 55 fathoms of water, stony ground with some shells; but at 7 leagues distance to the northward, you will have sand and oaze mixed together.

The Seven Stones are a dangerous reef of rocks, which appear above water, some at half tide, and some at low water. They are a mile in extent from N.N.W. to S.S.E. The sea always breaks upon them; and, except in very bad weather, they may be seen from a considerable distance. The

Pollard Rock, on the N.W. side of this reef, lies 14½ miles W. by N. ½ N. from the Longships lighthouse, with the Daymark on St. Martin's W. by S. ½ S. 7 miles distant. The Telegraph Station on St. Mary's* bearing S.W. ¾ W. leads 2¼ miles North of the Seven Stones.

The *lightvessel*, showing two fixed bright lights (to be altered to triple flashing light in May, 1879), is moored in 40 fathoms of water, about 1¾ mile E. ½ S. from the *Pollard Rock* of the Seven Stones, and about the same distance N.E. by E. ¾ E. from the South Stone. A *fog-horn* is sounded on her in foggy weather at intervals of 10 seconds.

Vessels navigating between the Scilly Islands and the Land's End should endeavour to bring the lightvessel to bear to the westward of South, when coming from the northward; and those approaching the lightvessel from the southward, should keep her to the westward of North.

HARTLAND POINT.—The land of Hartland Point is very high, and directly from it, to the distance of about one-third of a mile, is a ridge of rocks, on which the sea breaks very heavily. The mark to clear these rocks on the West is *Sharp's Nose*, S.W. by S. ¼ S., or kept well open. This Sharp's Nose is a high bluff land, nearly 3 leagues to the southward. The mark to clear the rocks on the North is, *Gallendy*, or *Gallantry Bower*, to the West of *Clovelly*, with a tuft of trees on it, kept open, or bearing S.E.

Hartland Point may be readily known from the connecting cliffs trending nearly at right angles to each other. It appears of a dark brown colour, and its summit resembles the ruins of a building, elevated 350 ft. above the sea, toward which it slopes abruptly to the perpendicular cliffs. The *lighthouse* on the point was established in the year 1874. Its *revolving* light; shows alternately at intervals of half a minute a bright flash twice, and a red flash. A powerful *fog trumpet* is sounded for five seconds in every two minutes in thick weather.

Hartland Point forms the S.W. point of the Bristol Channel.

Should a vessel be forced into the entrance of the *Bristol Channel*, so that she cannot lay out again, the most prudent course is to proceed as directly as possible, for Milford Haven; but, should the weather be thick, and circumstances prevent this, she may proceed to Lundy Island, there anchor, or take a pilot for the harbour of Ilfracombe. By obstinately endeavouring to beat out of the channel, many lives and much property have been sacrificed; it being next to impossible for a vessel to get to windward here, when opposed by the swell and indraught.

A vessel from the *Longships*, if bound into the Bristol Channel, with the wind from the N.E., should stretch as far to the North as she can, and to the westward of the rocks (the *Man and his Man*) off St. Agnes' Head, and then work up in the slack. With an easterly wind you may find a good stopping place for a tide, on the western side of Trevose Head, sheltered by the *Cow and Calf*. In the great bight northward of this, between Tintagel

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* *St. Mary's.*—On the South point of St. Mary's, called Peninnis Point, is a Signal Station. Vessels making their names by Commercial Code are reported in the *Shipping Gazette*, and to the owners if required. There are also stations at Penzance, the Lizard, Prawle Point, St. Catherine Point, Yarmouth, Dungeness, Dover, Deal, and Broadstairs.

Head and Hartland Point, the tide is quite slack, and a vessel may gain ground against the ebb.

With the wind to the South or S.E., and a commanding breeze, you may run between the Longships and the main, or haul close round the Longships within a cable's length, and keep the English shore on board: for so soon as you bring the Longships and Brissons nearly in a line you will gain the true channel tide.

Spring tides, as already noticed, set very rapidly in the Bristol Channel. When the wind is to the S.S.E. in the channel, the stream westward of Hartland Point is mostly found setting S.S.W.

Pilots for Bristol may be engaged at Lundy or Ilfracombe. Vessels bound to Bristol, or any port well up Channel, are recommended, in general, to keep near the English shore, though without going into any of the bays, after passing between Lundy Island and Hartland Point.

MILFORD HAVEN has been generally considered as the most capacious, the most commodious, and the most secure harbour in the British Islands. It was usual formerly to state that "there was no sort of danger on its entrance that could not be avoided without a pilot," an assertion based on the supposed accuracy of the elaborate Admiralty Survey; but an accident led to a closer examination, which showed that the entrance is bestrewed with dangers to vessels of the largest class at dead low water.

St. Ann's Head is a bold promontory, advancing from a back ground of nearly table land, with a large black rock at its extremity, always appearing above water. At 4 cables' lengths W. by S. from the high lighthouse is the end of a rocky spit, with 3 fathoms on it, lately discovered, and at half a mile S.S.W. from the high light is another patch of 4 fathoms. The lighthouses on the western side are whitewashed, and in thick weather a *Fog-trumpet* is sounded here. This point lies N.E. $\frac{1}{4}$ N., $33\frac{1}{2}$ leagues from Cape Cornwall; N. $\frac{2}{3}$ W. 47 miles from Hartland Point; and N. $\frac{3}{4}$ W., $34\frac{1}{2}$ miles from the North end of Lundy Island.

To enter the haven with a fair wind, at any time before half ebb, give St. Ann's Head a berth of one-quarter of a mile, in a depth of 12 or 11 fathoms, then steering so as to bring the lower light (which shows exclusively in the haven) to bear W. $\frac{1}{2}$ S., and afterward running E. $\frac{1}{2}$ N. about $1\frac{3}{4}$ mile, the depths will decrease to 8 and 7 fathoms, and you will be in the middle of the harbour.

The two lights on Great Castle Head, facing the entrance, when in line N.E. by E. $\frac{2}{3}$ E. lead in the best water between St. Ann's Head and Mid-Channel Rock by night.

In the entrance to the haven the first danger met with was only discovered in the latter part of 1851—a very singular circumstance, considering that the whole of the coast was supposed to have been carefully and completely surveyed, as has been before remarked. It is a small patch, called the *Lewis Rock*, or Mid-Channel Rock, $1\frac{1}{3}$ cable's length from N.W. to S.E., and having only 18 ft. least water at its S.E. extremity. It lies exactly on the line of the two lighthouses at St. Ann's in one, or N. by W. $\frac{1}{2}$ W., and nearly a mile from them. A spiral buoy, painted in *red and white horizontal bands*, with *staff* and *diamond*, marked "Mid-Channel Rock," is placed near it. Besides this rock there is another, discovered at the same period, called the *Sheep*

Rock. It is a small patch of 4¾ fathoms, lying half a mile due West of Sheep Island. Both of the patches have deep water around them.

Another sunken rock, called the *Chapel Rock*, which lies at the distance of half a mile, W.N.W., from Rat Island, and has 15 ft. of water over it at low spring ebbs, is marked by the two following buoys:—A can buoy, painted in *red and white vertical stripes*, lies to the eastward; and a buoy painted *red*, is laid to the westward of the rock in 6½ fathoms. The *striped* Chapel Rock Buoy marks the port side of the eastern entrance, and the *red* buoy the starboard side of the Western entrance.

A rocky shoal, called the *Harbour Rock*, having 20 ft. over it, lies at the distance of nearly half a mile, N.W. by W., from Thorn or West Anglo Point without the islet off that point. The channel between these shoals and the western shore is nearly a mile in breadth, and by night the *red* light is shown over them from St. Ann's high lighthouse.

The course in is N.E. by E. ⅔ E. (on which bearing the lights on Great Castle Head are in one by night), until you open Dale Road, in the N.W. corner of the Haven. Here you may come-to, in 2 or 3 fathoms, so soon as Dale Town comes open. But be cautious of not mistaking a bay on the West side of Dale Road, as it is dangerous. Large ships should lie further out, at the distance of about 1½ cable's length, N.N.E. from Dale Point, where there will be found 4 fathoms of water. The best channel up to Milford, and that commonly used, is to the southward of the Stack. Upon the South side, hereabout, is excellent ground, in from 8 to 13 fathoms, where ships may lie landlocked from all winds.

At the distance of a mile S.S.E. from the Stack lies *Angle* or *Nangle Bay*, in which the ground is clear and good. In this place vessels, having lost their cables and anchors, may run aground on soft oaze; but should keep nearly in mid-channel between the outer points.

The most convenient and common anchorage for large ships is in *Hubberston* or *Man-of-War Road*, at the distance of 4 miles to the E.S.E. of Dale Point. In sailing for it, keep in mid-channel until the town of *Milford* bears N.E. by E., when you may anchor in 10 or 12 fathoms. On either side, stand no nearer to the shore than to the distance of 1½ cable in length.

SMALLS.—The Smalls consist of a cluster of low bare rocks, upon the largest and westernmost of which is the *lighthouse*, a granite tower, 141 ft. high from base to vane, painted in red and white bands. The light is brilliant and fixed, 125 ft. above high water. A *bell* is sounded in thick weather, and *explosive rockets* are in use.* The rocks are about one-fifth of a mile in

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* Rocket Signals.—This sound signal (established in 1878) consists of a charge of gun cotton in a rocket head which explodes at a considerable height, and discharged during thick and *foggy weather*, day or night, every half hour. The effect of this signal will more closely resemble that of a gun than an ordinary rocket, little light being shown. Mariners should observe that this rocket is a fog signal only, and not a summons for assistance.

Also, that should assistance be required at the lighthouse, or by passing vessels, the signal will be a Call Rocket of great brilliancy, showing a magnesium flame in falling, as well as a vivid rising trail; this rocket, which will only be used at night and in clear weather, will be fired at frequent intervals.

extent, but very narrow, in a N.E. by N. and S.W. by S. direction, and are never entirely uncovered.

There are several detached rocks at the distance, more or less, of one-quarter of a mile from the main group, which must be carefully avoided.

Passages between the Smalls and Hats.—When the Hats are seen to break, this is a good and safe channel, although not more than $1\frac{3}{4}$ mile wide. If the South Bishop, distinguished by its lighthouse, can be made out, this islet, just open of St. David's Head, will clear all.

To clear the Smalls, Hats, and Barrels, to the northward, care must be taken to give the Smalls a sufficient berth to clear the N.E. rock, the transit of which is passed when the lighthouse bears S.W. by W. $\frac{1}{4}$ W. When the land is distinguishable, an excellent clearing mark is, the N.E. end of Grassholm on with the S.W. end of Skomer; this will lead at the distance of about three-quarters of a mile from the Hats, and $1\frac{1}{4}$ mile from the Barrels.

To clear the Smalls and Barrels, to the southward, the Smalls ought not to be approached within 1 mile, on coming from the westward, until the lighthouse is brought to bear North, in order to avoid the S.W. rock, as the soundings are extremely irregular, varying at that distance from 40 to 25 fathoms, generally gravel and broken shells, so that no dependence can be placed on the lead. At night, the Smalls light must not be brought to the westward of N.W. $\frac{1}{4}$ N., nor St. Ann's light to the southward of S.E. by E. $\frac{1}{2}$ E.; these bearings will give the Barrels a berth of about $1\frac{1}{4}$ mile. Observe well that the moment St. Ann's light is unmasked to the southward of Skokham, a vessel is nearly in the line of direction of the shoals.

Vessels bound to Milford Haven, &c., from the S.W. of Ireland, are recommended to make Grassholm, frequently the first land seen, by day, or the Smalls lighthouse by night. Should there be a long flood to run, it will be the best, particularly with the wind to the southward, to pass well South of the light, or to try and make St. Ann's light upon a bearing of E.S.E. $\frac{1}{2}$ E, passing outside Skokham: but on an ebb tide, opposite precautions may be taken; and having passed to the northward of the Smalls, keep St. Ann's light open between isles Skomer and Skokham, bearing about S.E. by S., which will lead between them.

ST. GEORGE'S CHANNEL.—To give extended descriptions of this important navigation would swell this work far beyond its proper limits. On pp. 452—459 are given some general instructions for sailing up and down this channel, which must suffice. One especial point requires every attention, and that is the set of the tides. In pages 307, 308, are given the general features of these currents, which, being neglected, have led to several deplorable accidents on the banks off the S.E. coast of Ireland. It is therefore most earnestly recommended to the sailor to pay every attention to this important subject.

On the eastern side of the channel the indraught to Cardigan and Caernarvon Bays is in some degree deprived of danger by the establishment of the lightvessels described in the list, which will warn a ship from passing too far to the eastward, and thus getting embayed on this iron-bound shore and its dangerous shoals.

The Refuge Harbour at Holyhead has assumed an important position in

the navigation, and will afford shelter from bad weather for a large portion of the compass. St. Tudwall Roads, in the northern part of Cardigan Bay, will also be found a valuable place of shelter, now that it is so well lighted.

SOUTH COAST OF IRELAND.—As ships bound across the Atlantic may be driven to seek shelter on the Irish coast, a few brief notices of the principal places on the southern coast follow. Complete descriptions of the whole coasts of Ireland are given in our Directories, accompanying the charts.

CARNSORE POINT lies N. by E. $\frac{1}{3}$ E. 41$\frac{1}{2}$ leagues from Cape Cornwall, and from the Smalls lighthouse, N. by W. $\frac{3}{4}$ W. 37 miles.

To the E.S.E. $\frac{1}{4}$ E., at the distance of 6$\frac{1}{2}$ miles from Carnsore Point, is the remarkable rock called the *Tuskar*. Its bearing and distance from the Longships lighthouse, off the Land's End of England, are N. by E. $\frac{3}{4}$ E. 42$\frac{1}{2}$ leagues; and from the Smalls lighthouse, N. 4^{c} W. 11 leagues.

The Tuskar Lighthouse shows a revolving light every minute, twice bright and once red alternately. A *bell*, sounded every half minute, denotes the proximity of the rock in foggy weather, and a *gun* is to be established. The rock is about 15 ft. above the sea at high water, and the elevation of the lighthouse 101 ft. above the base. The bright lights may be seen at 5, and the red light at 4 leagues off. A bell is sounded in thick weather.

At half a mile due West of the lighthouse are some rocky heads, and at three-fourths of a mile S.W. of the light is the *South Rock*, of 9 fathoms; to avoid these, be careful to keep sufficiently without the rock on that side. And nearly midway between the Tuskar and main is the long, narrow bank, called the *Bailies' Prong*; the ripple on the South end of which bears from the Tuskar West, and from Carnsore Point E.S.E., about 2$\frac{1}{2}$ miles. The bank extends nearly 3 miles N. by E. $\frac{1}{4}$ E. Its shoalest water is from 5$\frac{1}{4}$ to 7 fathoms, with 8 and 10 fathoms near each end. To clear it on the East side, keep nearer to the Tuskar than to the main.

The Saltees Lightvessel, showing three flashes (during 23 seconds) once in every minute, lies in 32 fathoms, with the Great Saltee bearing N.E. $\frac{1}{4}$ E. about 4$\frac{1}{4}$ miles distant; the Hook Lighthouse of Waterford Harbour, N.W. $\frac{1}{4}$ W. 11$\frac{3}{4}$ miles; and the Tuskar Lighthouse, nearly East, 20$\frac{1}{2}$ miles. Between the lightvessel and Great Saltee Island lie the Coningby and Coningmore Rocks.

A *fog-trumpet* is established on the Saltees lightvessel, giving a blast of 5 seconds duration, followed by an interval of 20 seconds; a second blast of 5 seconds duration will then be given, which will be succeeded by an interval of 4$\frac{1}{2}$ minutes before the next blast is sounded.

WATERFORD HARBOUR, is the estuary of the Rivers Suir and Barrow. From the Longships Lighthouse, off the Land's End of England, the Hook Point of Waterford bears N. by W. $\frac{3}{4}$ W. true, and N. $\frac{1}{3}$ E. by compass, nearly 43 leagues; from the North end of Lundy Island, off the Bristol Channel, N.W. by W. true, and N.W. by N. nearly, by compass, 33$\frac{1}{2}$ leagues; from St. Anne's lights, Milford Haven, W.N.W. $\frac{1}{4}$ W. true, and N.W. by compass, distant 23$\frac{1}{3}$ leagues; and from the Smalls Lighthouse W.N.W. northerly, true, and N.W. $\frac{1}{4}$ N. by compass, distant 17$\frac{1}{2}$ leagues.

Upon *Hook Head*, or the Hook Point, is a tower, painted red and white in horizontal bands, 115 ft. high, which exhibits a brilliant *fixed light*, at 152 ft. above the level of high water, and seen from all points between E.N.E., seaward, to N.N.E., 17 miles off. There is a *bell* sounded in fogs.

The entrance of the harbour between Hook Point on the eastern, and Red Head on the western side, is $2\frac{3}{4}$ miles wide. Three miles within these points on the western side, is the remarkable promontory, called *Credan Head*, the extremity of which bears N. by E. $3\frac{1}{4}$ miles from Hook Point.

The pier at the little harbour of Dunmore, on the West side of the entrance, affords a secure anchorage with westerly gales, as well as from the prodigious sea which rolls along the southern coast, but it is not calculated for an asylum harbour, from its space being very confined, and its want of depth, there being only one spot within the pierhead with more than 14 ft., and 9 to 12 ft. being the ordinary depth at low water.

In coming in from sea for Waterford Harbour, you will descry the remarkable inland mountain called the *Slievnaman*, which should be brought to bear N.E. $\frac{1}{2}$ N., as it will, with that bearing, lead in sight of Hook Tower; whence you may round Hook Point, which should not be approached nearer than to the distance of 2 cables' lengths, as the tide sets round it very irregularly.

With the entrance open, the course to Duncannon Fort will be N.E. by N., which will lead past Credan Head, at the distance of $1\frac{1}{2}$ cable's length. In the night the *two lights* will be seen on the Fort of Duncannon, elevated one above the other, to direct vessels to that point. These kept open of Credan Head, and bearing N.E. $\frac{1}{2}$ N., lead directly up the harbour. The *Bar* is marked by *three buoys* at $1\frac{1}{4}$ mile above Credan Head. That to the East is a *black nun*, and the two to the West are *red can* buoys. After crossing the bar, keep the Duncannon lights in one, and then bearing to the West pass the fort at the distance of about 1 cable's length, keeping the lead going, and then steer N. $\frac{1}{2}$ E. for Ballyhack church. When the Iron Pile Lighthouse, near Passage, comes on with the town of that name, you may steer upward in mid-channel, keeping the light open on the port bow, and while passing it, giving it a berth of half a cable. A vessel will thus pass through the best part of the channel leading to the Passage anchorage, and can bring up in safety.

Ballycottin Bay, on the North of the Ballycottin Isles, has been recommended as a place of safe resort in westerly winds. The only disadvantage of this anchorage is, that the wind setting in from S.E. to E. (which wind, however, *very seldom* blows) renders it necessary for vessels to put to sea as quickly as possible. The prevailing winds on this coast are westerly throughout the year; therefore this anchorage is safe and convenient with the wind from S.W. to N.N.E. by the North. Vessels taking shelter from a westerly gale, should anchor with the Government houses bearing S.S.W. to S.W, and the outer island S.E. to S.S.E., in about 3 fathoms, low water. The bottom is smooth and even, of fine sand and clay, perfectly clean, and the holding-ground good. The outside island, on which is the lighthouse, is high, with a bold, rocky coast, steep-to, with deep water, and no dangers; so that a vessel, in taking the bay from the westward, may round the island close-to, and find herself suddenly in smooth water.

CORK HARBOUR.—The entrance of this excellent harbour lies at the distance of 46 leagues N. by W. ¾ W. (*N.W.* ¼ *N.*) from the Longships Lighthouse off the Land's End of England; and from St. Anne's Point, Milford Haven, nearly 39 leagues N.W. by W. ¾ W. (*W.* ¼ *N.*) In coming up for this place from the southward, bring Knockmeldown Hill, N.E. by N., keep it thus until you see the Old Head of Kinsale, which is a remarkable bluff headland, with a lighthouse upon it. From this head the entrance of Cork Harbour bears E.N.E. 5 leagues.

When off the harbour, Roche's Tower and lighthouse are remarkable on the point upon the eastern side. Without this point are two rocks, called the *Cow and Calf*, otherwise the *Stags*, which dry at low water, and will be avoided by attending to the following directions. Without the entrance, which is three-quarters of a mile broad, the ground is clean; and, with a northerly wind, ships may lie here, in from 7 to 10 fathoms, awaiting the daylight, or a flood tide. With a leading wind, ships may enter at any time of the day, if proper attention be paid to the marks for the dangers.

The Lighthouse on Roche's Point exhibits an intermittent light, showing bright for 15 seconds, and eclipsed for 5 seconds alternately. The tower is white, 49 ft. high, and the light, which is shown at 98 ft. above the level of high water, may be seen at 10 miles off, from all points seaward between S.E. by E. and N. by E.

At the base of the tower a *fixed bright light* is shown, to mark the position of the *Daunt's Rock*, 4½ miles to the S.W. The light is shown between the bearings of S.W. by W. and S.W. ½ S. In approaching Cork Harbour, therefore, keep eastward of the limits of the fixed light until the rock be passed.

A *fog-bell* is sounded twice in a minute during thick or foggy weather. There is also a Commercial Code *Signal Station* on the point.

Daunt's Rock Lightvessel lies in 14 fathoms water, 8 cables S. by E. of the rock, and shows a *fixed red light*. There is also a large buoy to the N.E. of the rock, and in thick weather a *gun* is fired twice, with an interval of 5 minutes, once in every quarter of an hour.

Roche's Point is bold; so also is *Dog's Nose*, a high point half a league further in, and N. by E. from Roche's Point, on the same side. Upon the latter, some remarkable white walls lie on the face of the cliff, to the southward of the fort.

From the entrance of the harbour to the Narrows, in the upper part of it, and through them to the anchorage of Queenstown, the channel is marked by a double series of buoys, *red* on the western side, and *black* on the eastern. Besides these there are two buoys on the *Harbour Rock*, and two on the *Turbot Rock*.

On entering the Harbour of Cork, the channel eastward of the Harbour Rock and Turbot Bank is generally preferred, and a vessel may, at any time, be worked in or out. On coming in, therefore, endeavour to pass between Roche's Point and the Harbour Rock, or between the Harbour Rock and Turbot Bank. The first route may be easily effected by keeping Cuskinny House wholly shut in with the point at Dog's Nose; this mark also leads to the eastward of the Turbot Bank. The depths in the channel are 5, 6, and 7 fathoms. To pass between the Harbour Rock and Turbot Bank, keep the

white house in Ringabella Bay twice its own apparent breadth open to the southward of the Beaulna Cove Point.

Having arrived within or to the northward of the rocks, which will be when a round stone martello tower, on the heights near Ringaskiddy (westward of Spike Isle), appears four times its own breadth open to the northward of the lowest part of the declining land under Fort Camden, thence steer for the middle of Spike Island, keeping as nearly midway as possible between Forts Carlisle and Camden, until two remarkable houses, inland, to the northward of Cuskinny House, and eastward of the old barracks, appear, the northern house between Cuskinny House and the southern house, three-fourths nearer to the latter than the former. This mark will lead up between the shoals towards Queenstown.

Continue running upon the mark last given, until two whitewashed marks in the upper and lower walls of the old fort or hospital appear in one, and when Ballybrickan House comes nearly into contact with the S.W. angle of the buildings on Haulbowline Island, you should haul suddenly to the westward, steering N.W. by W. toward a large storehouse on the upper quay at Queenstown, for about 2 cables' lengths, and then W.N.W. parallel to the beach of Queenstown, until Roche's light-tower shuts in with the eastern end of Spike Island. The last mark is the best for anchoring, and where you will have from 4 to 9 fathoms of water.

The *Outer Road*, or anchorage of Cork Harbour, is between Fort Camden and the buoy of the spit. You proceed up to it with Queenstown church just shut in with the eastern angle of the citadel on Spike Island, and may take a station at pleasure in from 12 to 7 fathoms. Merchant vessels may ride off Queenstown, in smoother water and less tide; they may also anchor further up the harbour, off Passage, and ride anywhere between the first houses and Marino Point.

Those working into or out of Cork Harbour should be aware that the tide sets, in the first instance, into the bight formed between Dog's Nose and Roche's Point, and then obliquely across to Cross Haven, whence it is again warped into a N.E. direction, which produces corresponding counter tides and eddies along both shores. The tide of ebb has a directly opposite tendency. The time of high water, &c., is shown in the conclusion of this section.

KINSALE.—From Poor Head, which lies 4 miles eastward from Roche Point, the Old Head of Kinsale bears W. by S. 6 leagues. Two whitewashed towers stand on the cape, and between them are the black ruins of Baron de Courcy's Castle. The southern tower is round, the northern square. The southern was formerly the lighthouse.

Old Head Lighthouse is erected on the rocky point at the southern end of the *Old Head of Kinsale*, distant half a mile S.S.W. $\frac{1}{2}$ W. from the old lighthouse tower. The light is a *bright fixed* light, elevated 236 ft. over the level of the high water of spring tides, illuminating an arc from N.E. $\frac{1}{2}$ N. seaward, to W. by N. The tower is circular, and 100 ft. in height from its base to the top of the dome, and is marked by two horizontal belts, coloured *red*.

On the arc limited by a line across the entrance of Courtmacsherry Bay, between a line drawn to the Seven Heads and another line drawn to the

Horse Rock from the lighthouse, it is coloured *red*; further within the bay, northward of that line, it is of the natural colour. Thus vessels, unless going to Courtmacsherry Harbour, should not pass into the bay within the limits of the red colour of the light.

In order to fall in with the Old Head, when approaching from the offing, bring and keep Knockmeldown Hill N.E. by E. This hill lies inland to the northward of Youghal.

The *Harbour of Kinsale*, though narrow at the entrance and all the way up to the town, is very safe, and capable of receiving vessels of any size. The entrance is formed by *Hangman and Prehaun* Points on the eastern, and *Money* and *Strookaun* Points on the western side; and it lies about 5 miles N.E. from the pitch of the Old Head. After rounding the *Breem Rock*, lying under the eastern side of the Head, with 7 fathoms close to it, steer for the harbour's mouth, by keeping the whole of Charles Fort, an extensive castellated building at a mile within the harbour's mouth, open to the westward of Hangman Point, and minding not to bring that fort within its own apparent breadth of Money Point, on the port side; and having reached well within the former point, keep as near mid-channel as possible, and anchor until you obtain a pilot. The anchorage of Queenstown is the one generally resorted to, and it affords good shelter, even with the wind directly in. This place is a little within or to the N.W. of Charles Fort, and about $1\frac{1}{2}$ cable from shore. There is, however, water enough for the largest ships close up to the town of Kinsale, the channel to which lies close along the eastern shore; but it is very narrow and circuitous, and requires the assistance of a pilot. The wind between S.S.W. and E.S.E. is a free wind in, and from W.N.W. to N.E. a fair one out.

There is a bar of coarse sand a little to the southward of Charles Fort, having 12 to 18 feet over it at low water of spring tides. When the body of Charles Fort bears E.S.E. $\frac{1}{2}$ E. you will be within or to the northward of it, and drop thence almost immediately into deep water.

The dangers on going into Kinsale Harbour are, *Farmer Ledge* on the port, and the *Bulman Rock* on the starboard side. The Farmer lies close to the western shore, and is uncovered at three-quarters ebb. The Bulman lies above 2 cables' lengths to the southward of Hangman Point, and has only 3 feet over it at low water, and sometimes dries at very low tides. A *red* can buoy is moored to the S.W. of it. The marks for it are, the northern angle of a triangular field on with the peaked top of Crow Head, and the Small Sovereign Island on with Froward Point. By keeping Charles Fort wholly open to the westward of Hangman Point, you will pass considerably to the westward of the Bulman; and by not bringing that fort within its own apparent breadth of Money Point, you will avoid the Farmer.

During the night a *light* is kept on Charles Fort as a guide to vessels entering the harbour. It is *bright* and *fixed*, at 98 feet above the sea, open to the harbour, on a N.E. by E. bearing, and may be seen in clear weather 14 miles off. When running for the harbour in a very dark night, some caution is, however, necessary, as this light and that on Old Head are the only guidance, and it will be prudent to keep an offing until daylight, or till a pilot can be obtained.

To the westward of Kinsale, the S.W. coast of Ireland is well lighted,

the chain of lights having been completed in 1877 by the fine light on Galley Head. These lights are all sufficiently described in the Tables of Lighthouses given in the early portion of this book.

Cape Clear, the southermost promontory of Ireland, upon an island of the same name, lies at the distance of 54½ leagues N.W. by W. ½ W., *true* and N.W. ½ N. by compass, from the Longships lighthouse, off the Land's End of England; and at the distance of about 5½ miles eastward from the S.W. part of this island lies the entrance to the harbour of Baltimore.

A lighthouse was erected on the S.E. side of Clear Island, to the eastward of the Cape, and was first lighted on the 1st of May, 1818, but it was superseded by the more important light on the Fastnet Rock, to the S.W.

THE FASTNET ROCK, a small, steep, and conspicuous rock, lies nearly 5¼ miles W. by S. from Cape Clear. Between is a depth of from 12 to 35 fathoms, the least depth being near to the rock. The *lighthouse* is 92 feet high, and has a broad red horizontal belt at mid-height. The light is elevated 148 feet, is revolving, visible once in every 2 minutes to the distance of 18 miles; but is not entirely obscured within short distances.

Between Cape Clear and the River Shannon, the land, on advancing to the North, increases in height, and is very irregular and broken; but the southern part of the coast is seldom wholly free from fog and haze during the summer months, and is generally annoyed by powerful gales and a turbulent sea during the winter season.

Long Island Sound, which lies within Long Island, to the S.W. of Skull Harbour, is well sheltered, of easy access, and capable of receiving large ships, which may enter at either end of the island, anchor anywhere, the ground being good. The only thing to be avoided is a spit of sand, which extends northward from shore, at about half a mile within the East end of the island, and more than halfway over the channel.

In the anchorages the depth varies from 2 to 7 fathoms, and the ground is everywhere a soft cohesive mud. The chief passages are, one from the S.W. between Goat Isle and *Turf Isle*, or the *Black Rock* to the westward of it, called *Man-of-War Sound;* one between Goat Isle and Long Island, and one between Long Island and Three Castle Island on the East. Either of these passages may be safely taken without a pilot, through water sufficient for a line-of-battle ship. When entering by the S.W. passage, you have merely to keep in mid-channel all the way through, as well as from thence to the anchorage.

Crookhaven is a small but important harbour, lying 8½ miles N.W. N. from Cape Clear. It is only two miles in extent, from East to West, by one-third of a mile in breadth. Its entrance lies between a rock called the *Alderman*, on the South side, and a peninsula called *Rock Island*, on the North. Although narrow, the harbour is well sheltered and commodious for vessels bound to the eastward; the ground is good, and the water more than halfway up, sufficiently deep for large ships. This is a very convenient place for vessels drawing 14 feet, during bad weather or easterly gales, against which it affords the most ample shelter; but it is to be regretted that the bottom has considerably risen, and the depth, in consequence, decreased about 2 feet.

A *lighthouse* is erected on Rock Island Point, at the northern side of the entrance. The light is a *fixed* white one. The lantern is open to seaward, and to the haven, from E. by S. to W. by N., and is elevated 67 feet above the level of the sea. The light appears *red* over the Alderman Rock and toward Streek Head, or when bearing between N.W. by W. and N. ¼ E. In anchoring by night, therefore, keep northward of the red light.

Having fairly opened the harbour, run directly in, keeping in mid-channel. The ruined signal-tower on Brow Head, three times its own apparent breadth open to the northward of O'Driscoll's house, a remarkable white one, entirely insulated, bearing West, will lead to the northward of the Alderman Rock, and into the fairway.

The opening of Crookhaven cannot be made out until you are very near the Alderman; to make it, therefore, steer in due North from the Fastnet Rock, keeping that rock South, as near as may be, until Mizen Peak comes in one with Alderman Head. In proceeding thus, you cannot be deceived because, at the same time, or nearly so, Mount Gabriel will appear in one with Leamcon signal-tower and castle to the N.E., and Brow Head, with its signal-tower, will appear to close in with Streek Head, to the westward. The harbour will now begin to unfold itself; the revenue officers' houses on the northern shore will first be seen, and, ultimately, Coghlan's tower, which stands as above explained.

A vessel cannot enter Crookhaven unless the wind is to the southward and eastward of S.S.W. by compass, or to the eastward and northward of N. by W.; but when the wind happens to be foul for Crookhaven, it will prove fair for Long Island Sound. You may anchor, with westerly and northerly winds, at a mile N.E. from the Alderman Rock, in very good ground, but great circumspection must be taken as to southerly winds.

Bantry Bay lies to the northward of Dunmanus Bay; it is large, safe and commodious for ships of any size. The stream of tide is scarcely sensible in any part of it; the water is sufficiently deep, almost close to both the shores; and there are no rocks nor shoals in the way, but such as may be easily avoided, even in the night. Ships may stop anywhere in the middle of the bay; or, in most parts, near to either side. The Bay extends nearly in the same direction as that of Dunmanus. It is 6 leagues in length, and from 2 to 3 miles broad. Its entrance, between Three Castle Head and Sheep Head, is 3½ miles wide. Off the latter point is a rock of 18 feet at 2 cables' lengths from its extremity. The depth of water throughout the bay varies from 10 to 31 fathoms, and the ground is of the most tenacious description. It is, however, much exposed to westerly winds; but even when these prevail, the harbours named *Bearhaven*, *Bantry*, and *Glengariff*, may be resorted to with great convenience, and even without a pilot.

Bearhaven is an excellent harbour, spacious, and well sheltered from all winds; the ground is everywhere good, and easy of access, in a country abounding with many necessary refreshments. Its proximity to the sea, and situation on the coast, render it an excellent rendezvous for a fleet.

The *lighthouse* on *Roancarrig Island* will materially assist the navigation of Bantry Bay, and more particularly that of the eastern entrance to Bearhaven, off which it stands. It is a white tower, with a red belt round it, showing

a *fixed* light at 55 feet, which may be seen at 12 miles off, between E. ¾ S. and N.W. by W. ½ W.

The haven has two entrances, one at the East end of Bear Island, and the other at the West end. The western entrance is the most direct and convenient for ships from the westward or southward; but the other is the safest for strangers. You may anchor anywhere off the North side of the island, in from 5 to 11 fathoms; but the best place is off Ballynakilla; and ships that wait for a wind only will find the West end of the haven most convenient.

Valentia.—*Brea* or *Bray Head* is the S.W. extremity of Valentia Island, which lies on the South side just within the entrance of Dingle Bay; the island thence extends 6 miles East, and forms the harbour of the same name, which is capable of receiving the largest ships. It affords excellent shelter against all winds that blow, with good holding ground in 36 and 42 feet at low water springs.

Those bound into this place should steer in for Doulus Head, giving the northern side of Valentia a berth of about a mile or more, until the remains of Cromwell's Fort, on which a light is established, bear S. by E., which will then be in one with the square tower of the church standing on a cliff of Valentia Island, considerably above the water's edge, and close to which stands the parsonage house, now in ruins. This mark leads to the entrance of the harbour. When passing Cromwell's Fort, keep one-third nearer thereto than to Beginnis, to avoid the reef projecting from the latter.

COAST OF FRANCE.—In the upper part of the English Channel, the coast of France is a part to be avoided by a passing ship. Upon it all the power of the tide and wave which traverse the Channel from West to East seems to be expended. Its shores are the depository of all the matter washed and worn off from the shores to the westward, and the light drifting sand of which they are composed, choke up all its harbours, and bar access to any shelter when required for a ship in distress. All this is explained in our Channel Directory; and in pages 304—306, *ante*, there are some remarks upon the Tidal Streams, which are very peculiar here, and require very much attention.

Ambleteuse Road, between Boulogne and Cape Grisnez, affords some shelter from gales between N.N.E. and S.S.E. round by the East; but the sea is very heavy, especially when strong winds appose the current, and moreover the tidals streams are at times very strong, so that the ship may become tide-rode in a very ugly position. Boulogne is difficult to enter on account of the thwart current.

The *Bay of the Seine* is very dangerous. It is open to all winds from N.W. to N.E., and the tides are very strong, so that ships embayed here with those winds are in great danger. There is some shelter inside the banks, which extend N. and S. of Marcouf, but the tides are so strong that they alone will embarrass, and the formidable Race of Barfleur, which runs around Cape Barfleur so turbulently, is much to be dreaded in N.E. gales.

CHERBOURG, with its majestic Digue, affords excellent shelter, and ample descriptions and directions are given in our English Channel Directions. The following are a few extracts:—

Cherbourg Road is comprised in the space between the Point de Querqueville and Pelée Island, lying E.S.E. and W.N.W., $3\frac{3}{4}$ miles distant from each other. Its southern limits are the shores of the two great bays, the Ste. Anne to the West, and that of Cherbourg to the East, divided by Pointe du Homet.

It is sheltered on the North side by a magnificent artificial breakwater, *La Digue*, built in 6 and 7 fathoms water.

The principal anchorages for large vessels and men-of-war are the Great Road, and the western anchorage; for smaller vessels, those called the Little Road, and the anchorage between the Pelée Island Bank and the eastern branch of the Digue.

The Bay of Ste. Anne does not offer many good spots for anchoring; the bottom is uneven, and the holding ground bad. And besides, vessels are in great danger if caught here by gales between N.E. and N.W., which send a bad sea into it.

The *Great Road* (Grande Rade) is the man-of-war anchorage, and is limited to the North and N.E. by the Pelée Island Bank; and extends to the West as far as the North of the Church at Cherbourg. In the North part, the bottom is, in general, of schistose rock in a state of decomposition, and the holding is good, but there are some spots of bare and cutting rocks. The current of the flood begins half an hour after low water by the shore, and ends three-quarters of an hour after high water in the military port. Its greatest rate is two miles, and of the ebb $1\frac{1}{2}$ mile an hour.

The *Western Anchorage*, lying to the South, and near to the West end of the Digue, is a fine bottom of sand and broken shells, four-fifths of a mile in extent, and with 6 and 7 fathoms water. It is bounded on the South by the rocky bottom, which, running from the Great Road, extends to the S.W. of the West end of the Digue. The current of the flood begins then nearly an hour after low water by the shore, and finishes an hour after high water at the military port.

The *Little Road* (Petite Rade) is to the South of the Great Road, in the part which is sheltered from West winds, and the sea occasioned by them, by Fort du Homet and the military port. In this anchorage, which is of good holding ground, the pilots place those vessels waiting for the tide to enter the commercial port. Strong winds from S.W. to S.E. are troublesome in this anchorage, as vessels are liable to drive and be carried on the rocky bottom of the Great Road, or even on to the Digue.

The anchorage to the South of the eastern branch of the Digue, which is used by vessels seeking shelter, lies between the Digue and the northern slope of the Pelée Island Bank, and extends from the Central Fort, where it is a quarter of a mile wide, to nearly the West end of the Digue, at which part it is narrowed to $1\frac{1}{2}$ cable in width. It is a sandy bottom, in some parts rather muddy, the depth varying from 26 to 32 ft. Vessels are here sheltered from N.W. to N.E. round by the North.

Western Entrance to Cherbourg Roads.—Large men-of-war enter by the

passes at each end of the Digue, the principal of which is the West, lying between it and the Chavagnac Fort.

You will run precisely in mid-channel, by keeping the little light-tower (with a *red* light) on the end of the eastern jetty of the Port du Commerce clear, but seen a very little distance West, that is, to the right of the battery of the Fort du Homet.

There is no difficulty in entering with a leading wind, but large ships beating in must give the Chavagnac Fort a berth, and take care of La Tenarde, off Fort du Homet. It is considered that it would be imprudent to attempt to beat in at night through the West Passage with large ships, unless there is moonlight.

The flood tide sets here S.E. and E.S.E., 3 miles at its greatest strength, and begins $1^h\ 30^m$ after low water by the shore, and ends $1^h\ 20^m$ after high water at the military port; the ebb current nearly the same, running to N.W.

The passage between the *Forts of Querqueville* and *Chavagnac* is nearly as wide as the former, but is not practicable for large vessels but between half-tides of high water. As the bottom is uneven, and covered with rocks, it is dangerous to anchor in it. No vessel should attempt it while it is calm, as you risk being carried on to the rocks at the bottom of Ste. Anne's Bay. There is no advantage in coming near the shore of this bay, with the wind from land, as it frequently comes in gusts, particularly with those from S.W.

The Eastern Entrance is comprised between the East end of the Digue and the western slope of the Pelée Island Flat; the most dangerous points of it are marked by buoys. The mark for this passage was a beacon on the rocks in front of the Hotel de Ville on with the church tower of Octeville, bearing S.W. by W. $\frac{1}{4}$ W., but this beacon has been lately removed.

The eastern passage is separated from the East part of the Great Road by the Pelée Island Bank, the breadth of which on the above bearing is 4 cables' lengths; the least depth on it being 22 feet. Besides being very narrow, it is inconvenient from the currents crossing it obliquely. This renders it dangerous for sailing vessels in light winds, and impracticable for them in calms.

The approaches are facilitated at night by the following lights:—The first is on the Guardhouse of Fort Querqueville. It is *fixed*, and 59 ft. above high water, visible 9 miles off. A *lifeboat* is stationed here.

The *second* is on the Central Fort of the Digue, 5,100 yards E.S.E. of the former. It is a fixed light, varied by a *flash* every three minutes, visible 10 miles off. The *third* is a *fixed* light, on the N.E. bastion of Fort Royal on Pelé Island, 1,750 yards S.E. by E. $\frac{1}{4}$ E. of the flashing light of the Central Fort.

A fixed *red harbour light* is placed at the end of the East jetty of the Port du Commerce, at 33 ft. above high water, visible 3 miles.

The extremities of the Digue itself are marked by a *green* light, visible 4 miles, on the eastern end; and a *red light*, visible 7 miles, on the western end.

The great bay which is formed on the coast between Cape la Hague and the Bréhat Isles, in which are the Channel Islands, is most dangerous to the

stranger. Its furious tidal streams; the countless rocks which cover and uncover to an enormous extent in the great range of tide, render it impossible in a few words to describe any of its navigation. Indeed, local and intimate knowledge alone can conduct a ship through any of its intricate passages.

ALDERNEY or Aurigny.—The eastern end of Alderney bears W.N.W., 8½ miles from Cape la Hague. This island is about 3½ miles in length by a medial breadth of three-quarters of a mile.

The coasts of Alderney are surrounded with rocks, which render the navigation difficult and dangerous; more particularly as the tides set strongly, and in various directions. The chief port, that of *Braye*, is on the North side of the island, and on the western side of Port Longy is a signal post.

Until of late years, Alderney possessed but two small harbours; one, called Port Longy, on the south-eastern side of the island, and the other, the old harbour of Braye, on the northern side, both of which dry at low water neaps. The *Harbour of Refuge in Braye Bay* consists of a breakwater for the purpose of enclosing Braye Bay. The N.W. breakwater is completed, and extends 1,609 yards in a curved and E.N.E. direction from the cape.

The breakwater shelters from westerly and N.W. gales the space within a line drawn S.E. by S. from the outer end of the breakwater to Roselle Point, including Braye Road, the old harbour of Braye, and the new harbour of *Craby*, which was constructed for the use of vessels employed in bringing material for the new works. The whole of the anchorage thus enclosed is sheltered from the N.W.; the inner part as far as North; and the portion between the Braye Rock and the breakwater is only open from E. by S., round northerly, to N.E. by E.

Two *fixed red* lights are exhibited at the head of the harbour of refuge to mark the fairway channel by night; the lower light is exhibited through a long tube which screens it in every direction excepting on a line through the middle of the fairway. This light is fixed on the parapet of the old pier at Braye, and elevated 25 ft. above high water at spring tides; it may be seen 5 miles off in clear weather. The upper light is fixed at the N.E. corner of Braye reading room S.W. by W., 370 yards from the lower light; it is elevated 55 feet above high water, and may be seen from a distance of 8 or 9 miles

BAY OF BISCAY.—In former pages, when the best routes to the southward were considered, the indraught into the Bay of Biscay is especially mentioned as a tendency to be avoided. (See pages 324—326, 463, &c.) But as it may sometimes happen that a vessel may get embayed without being able to weather its outer points, only a few remarks on its more available roadsteads will be given here. In the lists of lighthouses is given descriptions of these monitors which well mark its coasts, and by means of which a ship may avail herself of many anhorages, which it would occupy too much space to describe here.

USHANT (*Ouessant*) is a steep craggy island, about 4 miles in length from East to West, and 2 miles in breadth. On its S.W. side is a harbour, that of *Lampoul*, but of difficult access. The rest of the island is surrounded with rocks, a part of the North side excepted, where there is anchorage.

The anchorage on the North side is between Ushant and a little island named *Queler*, where vessels may lie sheltered from all winds but those from the northward.

Douarnenez Bay.—This capacious bay, which lies to the southward of Brest Harbour, will accommodate a large fleet, it being more than 6 miles in extent each way. Its entrance is so wide, and its bottom altogether so clear and regular, that no leading mark is required; provided that sufficient berth be given to several rocks which lie on the North side, as generally represented on the charts. *The course and distance from the S. W. end of Ushant* to the bay are, S.S.E. ¼ E. 10 leagues. There is nothing in the way that can take a ship up; only observing to avoid the *Basse Vieille*, off the Bec de Chévre, on the North side of the entrance. This rock lies about one-third over from the point, and appears just above water at two-thirds ebb. It is steep-to, having from 17 to 12 fathoms close to it. The marks for it are, Kidizient Mill, to the westward of St. Lawrence's Church, on with the middle of a reef of dry rocks which lie off the Point or Beck de Chévre, bearing E.N.E. ½ E.; a village, on with the N.W. cliff of the same point, bearing N.E. by E.; and the western Tas de Pois (or haystack), in one with the Toulinguet Rock off the Lighthouse Point. Its bearing and distance from the Bec de Chévre are, W. ¾ S. 1½ mile.

A clump of trees, with a small chapel in the midst, stands on the North side to the eastward of Point Chévre, having a windmill to the westward, and two to the eastward. With the windmill next to the eastward of these trees, just open of the Chévre Point, you will have passed the Basse Vieille, and may steer for what part of the bay you please, all being fair and clear, excepting what may be seen above water, and what may be near the shore. The best ground, however, is considered to be that toward the North side, being clear sand, with a depth of from 9 to 15 fathoms. The general depths over the bay are from 18 to 12 fathoms; and all, as before observed, is clean ground.

The best leading mark into the bay is the high mount of Locrenan (in the S.E.), just shut in to the southward of the Point Leidé, a rock on the West of the little bay of Douarnenez. This will lead, in a fair course, clear to the southward of the Basse Vieille.

The village of Douarnenez stands on the southern shore of the bay. A *red light* is shown on the head of the mole. Tristan Island, on which is a lighthouse showing a *fixed light*, visible 10 miles, lies off the village, and at about three-quarters of a mile northward of it is the outermost of two small sand patches, with 17 and 8 ft. water, which lie with the centre of the island in line with Plouaré Church. There is good anchorage off the village in 5 or 6 fathoms.

Chaussee du Sein, or Saints' Bridge, requires but little description, as it is clearly exhibited on the chart, and the lighthouses by means of which its position is indicated at night are fully described in the list of lighthouses. This extensive chain of foul ground trends 9 miles to N.W. by W. from the principal island, and is studded all over with rocks, either above or under the water. From the westernmost patch of 3½ fathoms, Ushant lighthouse bears N. by E. ½ E., distant 24 miles, and Ile de Sein S.E. by E. ½ E., 8⅓ miles, and a little open southward of Pointe du Raz.

BELLE ILE.—This island, being high, and seen from a great distance, may afford good shelter in a westerly gale. Its N.W. end is in lat. 47° 23′, and its South point in lat. 47° 16′. The N.W. end of the island is surrounded with rocks. In a line between the East end of the island and the Ile de Groiz, lies the rocky bank called the *Birvideaux*.

If a ship, with the wind at N.W. or W.N.W., keeps between the latitudes above mentioned, when running for the island, on approaching she may steer along the South side at the distance of 2 miles, to *Point de l'Echelle*, or *Point des Canons*, the S.E. extremity. From this point haul up for *Point de Kerdonis*, the easternmost point, which is situate 2¼ miles from the former. Under this point may be found anchorage, in from 15 to 8 fathoms, sheltered from N.W. and westerly winds. Should the wind here veer to S.W., a ship may run to the northward of the point, and anchor on the N.E. side of the island.

On the South side of the island there are many rocks near the shore, both above and under water.

Four lighthouses stand on the shores of Belle-Ile. On the North end of the island a *bright flashing light* is shown at an elevation of 112 feet on the Pointe des Poulains. This light in line with the light at Goulfar clears the Birvideaux Rocks. Near the middle of the S.W. side of the island, Port Goulfar light-tower exhibits, at 276 feet above high water, a white light, which *revolves every minute*, and is visible, in clear weather, at a distance of 27 miles. Care should be taken that this light is not mistaken for the revolving light on the Plateau du Four, 25 miles eastward of it. Lights are also established on the moles at Le Palais and Sauzon, in Belle Ile.

The *Isle of Hædic*, which lies about 7½ miles East from the East end of Belle Ile, has many rocks, with foul ground about them. The *fixed light*, near the eastern point of the isle, may be seen about 9 miles off. The *Cardinals* extend to the S.E from Hædic, and the extremity bears E.S.E. ¾ E., 12 miles from the S.E. end of Belle Ile. Should a ship be driven to the eastward of Belle Ile, she must give the Cardinals a good berth, and may then haul up to the northward for anchorage.

In the *Bay of Quiberon*, after you have brought the Cardinals to bear S.S.W., S. by W., or South, there is good anchoring, with clear soft clay, and very even soundings, in from 10 to 12 fathoms. With these bearings, you will be shut within some foul ground, lying off the Cardinals, in an extent of 3 miles in length, with the Cardinals from W. by S. to S.W. by compass.

BASQUE ROADS lie within the Isles of Ré and Oléron. The northern point of Oléron has a lighthouse, called the *Tour de Chassiron*. The rocks which surround this end of Oléron, called the *Antioche Rocks*, on which is a refuge beacon, extend 2 miles to the East of the lighthouse; but within them there is anchorage. The Tour de Chassiron exhibits a *fixed* light, elevated 164 ft. above the sea.

On sailing into the Roads, it is safest to keep over to the Isle of Ré, until near the S.E. end of it; only taking care to avoid the Lavardin, marked by a tower. Then steer for the West part of the Isle of Aix, a low fortified island, which lies about halfway between Oléron and the main land, and has a bright light on its South point, which bearing S.E. by S. will clear

the shoals off the East side of Oléron, and lead to an anchorage in the southern part of Basque Road. The roads extend from the Lavardin Shoal to this little island, and have from 10 fathoms close to the shoal, to 12 and 13 in the middle of the road; and from 5 to 9 fathoms at about 1½ mile to the North and N.W. of the Isle of Aix. There are 6 fathoms at half a league West from the island, and good ground.

The soundings in mid-channel, between the Isles of Ré and Oléron, are generally from 12 to 15 fathoms, shoaling towards each side. This channel is nearly 2 leagues in breadth. The French Man-of-war Road is on the South side of the Isle of Aix.

The Roche Bonne.—This very dangerous shoal is a great flat of rock situate between the parallels of 46° 10′ and 45° 15′, at 12 leagues westward from the lighthouse on Baleine Point. The plateau extends N.W. ½ W. to lat. 46° 15′, with a breadth of 2 or 3 miles. A *lightvessel* is moored on the East side of the plateau, in lat. 46° 12′ N., long. 2° 20′ 51″ W., and shows two *fixed white lights*. In clear weather they should be seen from a distance of 10 miles. During foggy weather a *bell* will be sounded for one minute at intervals of three minutes, but on a near approach will continue sounding. Too much confidence must not be placed in the vessel retaining her station.

The rocky bottom, situate to the N.N.W. of the Roche Bonne, is known to the fishers under the name of *Banche Verte*, and is not dangerous. Westward of the rocks, in all their extent, the bottom is of mud.

The GIRONDE.—The entrance of this river, with the banks and rocks that impede its navigation, are so clarly exhibited on the general chart of the bay, and particular chart of the harbour, as to render a minute description unnecessary. But care is requisite at all times, as the banks and channels shift very much. The lights are described in the list.

The Tour de Cordouan, standing nearly in the midway of the mouth of the river, is the most elegant lighthouse in Europe. This tower was completed in 1665; its original height was 169 French feet; but in 1727, the upper part being calcined, an iron lantern was erected, which increased its height to 175 ft.; and its elevation is now given as 63 metres, or more than 206 ft.

Its light is *revolving*, and visible to the distance of 9 leagues. The eclipses succeed each other once in a minute; but every great flash of light is immediately preceded by a flash less brilliant. In ordinary weather the eclipses do not appear total within the distance of 3 leagues. The light shows red to the north-eastward between N. by E. ¾ E. and E. by S.

Pass du Nord.—The mark for the entrance by day is the Church of St. Palais and that of St. Pierre de Royan in one, bearing S.E. ⅔ E. The churches lie on the North side of the river, and about 8 and 10½ miles respectively above Point de la Coubre; this direction will lead across the bar, and about one-third of a mile off Point de la Coubre, leaving the lightvessel to starboard, when off the latter point, and when the semaphore comes between the two beacons on the point, as given on the chart, you will have fairly entered, and should change the course to S.E. ¼ S., which may be continued for 8 miles, until the church of St. Palais bears North, about half a league distant. From the last spot a S.S.E. course, 6½ miles, will bring you up to *Mecher Road*, where there is good ground of sand and mud,

and from 8 to 10 fathoms at low water. The Passes are each buoyed according to the French system, *black* buoys to the left to port, and *red* to starboard in entering. Buoys painted *red and black* in horizontal bands may be passed on either side.

Should circumstances require it, you may run up and take shelter under the Point de Grave, which affords a safe retreat during westerly and S.W. winds. The mark is, Royan steeple and mills N.E. ½ N. At this place, between Verdon and the bank called the *Taille Fer*, coasting vessels are commonly sheltered in bad weather.

By night.—Vessels entering the Gironde by the Passe du Nord should approach by keeping the lights on Point de la Coubre and Palmyre in a line S.E. by E. ½ E. until the lightvessel on the Grand Banc is in one with the Cordouan light; keep these two in line until near the lightvessel, which pass to the northward, then steering eastward until the red leading lights of St. George and Sulzac are in one E.S.E. ¼ E., which are to be kept so until the lights of Tallais and Richard are in one. By day the lighthouses serve as leading marks.

The *Passe de Grave* is 12 miles southward of the Passe de Nord, and 8 miles in length. To sail through this channel, bring the light-tower (*fixed green light*) on the downs of St. Nicholas in line with that on Pointe de Grave (*flashing light*) E. ¾ N., and steer with these on until the Chay light-tower and that of Royan (*each a fixed red light*) are in line N.E. by E. ¾ E., proceed with these in line until the Talais floating light (*fixed white*) is in line with Richard light-tower (*fixed red*), which is the leading mark up to the anchorage in Verdon Road. If these marks are followed, 12 ft. at least will be carried over the shoalest parts at low-water springs; but if they are departed from, there must not be a greater depth than 8 ft. calculated upon.

In going through the Channel de Grave, be cautious of advancing too near the shore, as the tide of flood sets strongly upon it; and never, if avoidable, attempt to anchor in it.

No large vessel should attempt to leave the river by this channel, unless with a rising tide and favourable wind.

Tides.—At the entrance of the Passe de Grave, with the Cordouan Tower bearing N.E., the tides set as follows:—First of the flood, North; one-third flood, N.E.; half and two-thirds flood, E.N.E.—First ebb, S.E.; one-third ebb, South; half and two-thirds ebb, West. In the channel within, with Cordouan bearing N.N.W., the flood sets, generally, E.N.E., and the ebb, W.S.W. Between the great Bank of Cordouan and the Point de Grave the flood sets, generally, S.E.; the ebb from West to W.S.W.

The tides, both ebb and flood, set through the different channels with rapidity; and great caution is therefore requisite on making the river. Should the landmarks be obscured by thick weather, or if night comes on, it will be prudent to anchor in the first convenient spot.

Bayonne stands on the left bank of the Adour, at the confluence of that river with the Nive.

Care should be taken, when bound for the Adour, to keep to the northward of the entrance, if the wind has previously prevailed from N.N.W. to East;

but southward of it, when the wind has prevailed for five or six days from South to W.N.W. Experience proves that in the former case the current sets to the S.W., and that vessels have sometimes been carried down to the coast of Spain; and, in the latter, they have been drifted northward of the bar, where, finding no shelter, and being unable to keep off the land in bad weather, they have been stranded between the Adour and Vieux Boucaut.

To the North of the Adour there is no anchorage in bad weather, not even in the Fosse of Cap Breton. A vessel may, however, run for a chance of saving her crew on the beach at the head of the Fosse; but, to gain the entrance in bad weather, it is necessary to work off about 6 miles from the coast. To the North and South of the Fosse the sea breaks heavily on the sandy flats, where it is scarcely passable. It may be worthy of notice that in the event of unusually bad weather, and when a vessel can neither pass the bar or remain in the open sea, she can often seek refuge in the roadstead of St. Jean de Luz.

St. Jean de Luz Bay, at 10 miles S.W. of the Adour, is three-quarters of a mile wide and half a mile deep, and affords anchorage in 3 to 6 fathoms water, sand and rock. It has been made suitable for a harbour of refuge in bad weather by the construction of a breakwater about 30 ft. above the sea, extending from Socoa across the bay to the eastward. There are mooring buoys in St. Jean de Luz Bay.

At night.—Entering St. Jean de Luz Bay, bring Socoa fixed *bright* light to bear S.S.E., and steer for it; when the two fixed *red* lights on St. Barbe Point are in line, alter course and keep them so until the two fixed *green* lights at Siboure are in line; this last course leads between Socoa mole and Artha breakwater; when Socoa light has changed from white to *red*, haul to the S.W. for the anchorage, and anchor when the light appears white in the anchorage.

A red or tricoloured flag indicates that a vessel can enter the port; when it is hauled down, and a flag hoisted on the end of the jetty, the vessel should anchor.

COAST OF SPAIN.—Off the North coast of Spain, which is high, bold, and rocky, the depth of water, in general, is from 150 to 200 fathoms, foul ground and coral; but, in many places, there is no ground at that depth, even near the shore. The principal harbours on this coast are those of *Bilbao* and *Santander*; yet both of these are devious and shoal.

Bilbao.—Its entrance, which is 3 miles wide, is formed by the points, named Luzuero and Galea. On Galea is a lighthouse, showing a bright fixed light. The greater-part of its coast is lofty, steep, and rocky; but the bottom of the bay, on the eastern side, is low and sandy.

On *Cape Machichaco*, 10 miles to the eastward, is a lighthouse, showing a fine fixed light, varied by a flash every 4 minutes.

The mouth of the River Bilbao is impeded by a shifting bar, having less than 1 fathom over it at low water. Here are two piers or kays, within which is the town of *Portugalete*, and off which is the best anchorage in the harbour. Spring tides rise about 13 ft. In winter a heavy sea sets into the bay, which at times renders it impossible for the pilots to go off.

In coming in, when the tide does not serve for taking the bar, with an unfavourable wind, you may come-to in the bay, midway between the outer

points, Luzuero and Galea; bring the latter in a line with Cape Villano, in 16 fathoms, with sandy bottom. There is here sufficient room, in case a heavy on-shore wind should bring home the anchor or part the cable, to let go a second anchor, before the ship can get ashore. In summer you may lie nearer to the land, in from 10 to 12 fathoms, all the bottom being of sand.

On making the bay from the westward, *Point Galea*, on the eastern side, may be readily known by its white colour and lighthouse. Should you pass Santona, the bay may be thence distinguished by three sharp-pointed mountains; of these the northernmost is that of *Luzuero*, the middle one and highest, the hill of *Serantes*, on the West of the bay. The southern one appears like an island. On steering for the first, you will of course make Point Luzuero.

Pilots seldom await vessels eastward of Bilbao, as the land is generally made to the westward. A chief pilot, whose duty is to guide vessels across the bar, is always in attendance outside the bar, and his boat will be known by a *red flag*, with which he directs the vessel's course, when the entrance is practicable.

Santander.—Of this harbour a particular plan is given on the Chart of the Bay of Biscay. Cape Mayor with its revolving light visible 20 miles, is on the western side of the entrance. Cape Menor, or Little Cape, half a mile more to the S.E., has a battery on it. This is lower than Cape Mayor, and terminates in a low flat point, with a small reef of rock below it.

On the same side, at the distance of 1 3-10ths miles to the south-eastward of Cape Menor, is Point Puerto, where a green light is shown from a brick tower. Vessels coming from the westward will not sight this light until it bears S. $\frac{1}{2}$ W., on which bearing it clears the shoal water off Cape Mayor. The land between Cape Menor and Point Puerto forms the sandy *Bay of Sardinero*, in which vessels anchor, when the wind and tide do not serve for going into the harbour. The best anchorage here is with the Capes Menor and Mayor in one; and at 3 cables' lengths from the former you will find from 10 to 12 fathoms, bottom of sand; but more to the southward it is all of rock or stone.

The extensive sands on the South side of the harbour frequently shift, and a great portion of them is dry at low water. On the North side, from Point Puerto eastward, the coast is rocky, and defended by several batteries. The town has a small pier.

With the wind blowing fresh from the S.W. or N.W. quarters, it is impossible to take the *harbour* of Santander; but vessels may, with flood tide, occasionally bring up in the Road of the Promontory, which is clean and roomy, and there wait for a wind. With an ebb tide it will be better to come to in the outer bay, off the beach of Sardinero, as already described.

An islet named *Mouro*, which is high and steep, lies in the entrance at half a mile N.E. from Puerto Point; on it a bright light is established; close to its eastern side is a large rock, and there is a shoal at a cable's length to the N.W. of it; otherwise there is deep water around it, and the channels on each side are clear and good.

Although Santander is considered as the best harbour on the North coast of Spain, eastward of Cape Ortegal, there is little doubt that it is now filling up, and that the channel and even the anchorage now used may, in a few years, become impracticable. Pilots wait under the lee of Puerto Point, and it is compulsory on all vessels above 50 tons to take one.

On *Cape Penas* is a revolving light, visible every half minute; on *Cape Busto* (long. 6° 29′) is a bright fixed light with a *red* flash every 2 minutes; on the *Orrio de Tapia*, near Ribadeo, is another fixed and flashing light; and on *Cape Estaca* is a revolving light. These principal lights, with the others described in the list, will indicate the chief points of the coast.

CAPE ORTEGAL, Cape Prior, with the other headlands in the vicinity, are high and steep. The ground without generally rocky and foul. At the foot of Cape Ortegal are nine or ten sharp-pointed rocks above water, with 15 or 16 fathoms close to them; and there is a rocky shoal at half a mile N. by E. from the cape. A watch-tower on the highest land, at $1\frac{3}{4}$ mile from the cape to the southward, is a good mark for distinguishing it from seaward. Hence to Cedeira the land is steep and rugged, but to the northward of Cape Prior it falls into sandy bays. At different distances from shore are many scattered rocks, on which the sea breaks in a swell.

Both the stream of tide and current of the sea set in toward the land of this coast; so that the utmost attention is requisite, in order to avoid being embayed with light winds. With a good steady breeze, large ships may, however, pass safely within 2 miles of Cape Ortegal.

FERROL.—From Cape Prior to the Harbour of Ferrol the land is highly mountainous, with large rocks above water along shore. On Cape Priorino, $6\frac{1}{2}$ miles S.E. by S. from Cape Prior, a bright fixed light, varied by a *red flash* every 2 minutes, is shown. This cape, which forms the North side of the entrance of Ferrol, may be rounded at the distance of half a mile or less. The bay, forming the entrance of Ferrol Harbour, is only a mile wide; and the channel from it into the harbour but 2 cables' lengths in its narrowest part. There is, nevertheless, sufficient depth in mid-channel for large ships at all times of the tide, viz., 8 to 10 and 12 fathoms. When within, you keep over to the North side, where you may haul up, and anchor in from 4 to 6 fathoms, sheltered from all winds.

CORUNA, &c.—The North part of the Peninsula of Coruña is distinguished by the remarkable lighthouse called the *Tower of Hercules*, constructed with three sides, and exhibiting a fixed light with flash every three minutes. On the coast, without the elevation on which the lighthouse stands, there is a bank of rocks extending N.W. to a considerable distance; but, from the meridian of the lighthouse a ship may range along the coast into the harbour, to the S.E. and South, and find anchorage with the town bearing S.W. in 14 and 15 fathoms. A fixed light is also shown from St. Antonio Castle, and a *red light* on the mole head.

At 19 miles to the westward of Coruña is St. Adrian Point, off which are the *Cisargas Islands*. On the largest of these stands the lighthouse, which shows a bright fixed light, varied by a *red* flash every 4 minutes, at an elevation of 358 ft.

From **CAPE ST. ADRIAN,** the high land continues to the Bay of Camarinas, with rocks above and under water. *Cape Villano,* on which is a light-

house, is of rock, not very high, but perpendicular toward the sea. Within it, at a short distance, is a sharp peak, of a red colour, which at a distance appears like a tower. At the distance of a cable and a half N.N.W. from the cape is the *Rock of Bufardo*, steep-to, and over which the sea breaks.

CAPE TORINANA, which is 3 leagues to the S.W. $\frac{3}{4}$ W. [*S. W. by S.*] from Cape Villano, makes a sharp and steep projection into the sea; it is not very high. At a distance it is not always distinguishable from the high land at the back of it. E.S.E. 1 mile from Cape Toriñana is the African Rock, which breaks in rough weather. This coast must be avoided as much as possible on account of the sunken rocks lying off it.

The *Nave of Finisterre*, a high mountain, stands at the distance of $5\frac{3}{4}$ miles to the S. by W. $\frac{3}{4}$ W. [*South*] from Cape Toriñana. Its summit is flat; and at about one-third of its height from the sea there appears to be a short point with hummocks on it, and having at its base a small but high island. In the bay, formed between Cape Toriñana and the Nave of Finisterre, vessels may safely anchor during north-easterly and easterly winds, off a fresh-water rivulet, in from 6 to 8 fathoms, sandy bottom, but not in deeper water, as there the bottom is rocky. Care must also be taken not to advance too near the North shore, as it also is foul.

CAPE FINISTERRE is only half a league South of the Navé. It may be readily known from the sea; because there is a bight between it and the Navé with low beach, and the land behind less elevated. As there are no other points like these on the neighbouring coast, they cannot easily be mistaken. There is a lighthouse on it, which shows a bright revolving light at half-minute intervals.

PORTUGAL.—The coast of Portugal is varied with rocky prominences falling away into low sandy bays. Its harbours universally require the aid of pilots. Such are Viana, Oporto, Aveiro, and even Lisbon. The latter has, however, a good channel with 6 fathoms over the bar at low water, yet it should not be attempted by a stranger, lest the winds fall calm, and the strength of the current set him on the banks. Here the powerful operation of the tides has caused the destruction of many ships. Off the city the ebb runs down at the rate of 7 knots, and the danger in entering is when a strong ebb is running down, opposed to a strong wind from the sea, which makes a complete break, sometimes all over the bar. Under these circumstances a vessel is almost unmanageable, and the tide may sheer her about; but in the middle of the South Channel the tide sets directly through. To enter the river with a sailing vessel, during the ebb, would require a brisk gale and all sails set, in order to make any way, or even to stem the current; and it is to be observed, that within the river the wind comes very irregularly through the valleys on each side, unless it proceeds from the West or S.W. It is, however, tolerably steady when in the direction of the river.

CAPE ST. VINCENT.—A light is shown from the convent, revolving every two minutes, at 221 feet. About 50 yards from the Cape is a high isolated rock. Soundings extend to a considerable distance from Cape St. Vincent. To the southward of the Cape fishing-boats may frequently be seen at anchor, fishing about 8 miles off shore.

Off the Cape to the westward the surf, by beating on the precipitous and cavernous rock, may sometimes be heard to a surprising distance.

GORRINGE OR GETTYSBURG BANK, lying between the Madeira Isles and Cape St. Vincent, at about two-thirds of the distance from the former, was first discovered by Commander Gorringe in the U.S. steam-sloop *Gettysburg*, in December, 1876, while engaged in carrying a line of deep sea sounding between Gibraltar and the Azores for telegraphic purposes The bank was examined by Commander Egerton in H.M.S. *Salamis*, in March, 1877, this latter examination extending over four days.

The area of the Gorringe Bank, comprised within the depth of 100 fathoms, is nearly circular in shape, has an average diameter of 5 miles, and is included between the parallels of 36° 29½′ and 36° 34½′ N., and long. 11° 32′ and 11° 38′ W.

The shoalest part, within the depth of 35 to 30 fathoms, appears to be a narrow ridge 2 miles in extent, running nearly East and West; the least depth of 30 fathoms being confined to a small patch in lat. 36° 31½ N., and long. 11° 35½ W.

The nature of the bottom at depths under 50 fathoms was found to consist of rock and coralline matter; in depths exceeding 53 fathoms, pebbles, coralline substances, shells, and sand.

Beyond the depth of 100 fathoms the sounding increase rapidly. The depth of 1,000 fathoms from the shoal ground being about 5 miles in a northerly direction; 6 miles in a southerly; 13 miles to the westward; and 11 miles to the eastward. At 20 miles distant in a north-westerly direction, 2,750 fathoms were found, and in a north-easterly direction, 1,640 fathoms.

The tide was observed in H.M.S. *Salamis*, when at anchor on the shoal ground, on 4th March (spring tides), to set regularly N.E. and S.W., with a maximum velocity of about 1½ knot.

Fish in abundance were caught on the bank.

San Lucar, or the Port of Seville.—A vessel bound for San Lucar, or Seville, should, after sighting land, bring the town of San Lucar just open of the point on which stands the ruin of the Fort of Espiritu Santo, and with the Bonanza and Malandar lighthouses in one, bearing about East, steer for them until Espiritu lighthouse bears S. by E.; then keep a little to the northward, and bring Malandar lighthouse in one with the South end of Bonanza custom house, which will pass the Riza spit in 4 fathoms. When off the end of the reef, Espiritu lighthouse will bear about S. by W. ¾ W., and when the reef is rounded, steer for Salvador Castle till Malandar light bears N.W. ½ N., then steer about N.E. ½ E. for Bonanza Road, and anchor with the light bearing S.E. ½ E. in about 4 fathoms, sand. The lights are described in the table.

It is best to wait till flood tide to run in with. Weather permitting, a pilot may always be obtained, but they only put off when a ship is bound to the port.

It is recommended that no ship taking the bar of San Lucar should attempt it on the ebb tide, especially if they have any suspicion that there are freshes in the river, because, with a broken sea and strong tide, a vessel may sheer on shore before she could recover herself.

TRAFALGAR.—Cape Trafalgar, by the ancients called the *Promontory of Juno*, is about 15 or 16 miles to the eastward of Cadiz, and 23 or 24 miles to the southward of it; its appearance is flat, and distinguished by a white building, and a lighthouse showing a revolving light every half minute.

2.—THE COASTS OF AFRICA, FROM TANGIER TO CAPE MESURADO.

Caution.—Before proceeding with the description of the coast of Marocco, we will direct the attention to the following notice, issued by the British Consul, and which notice ought to be borne in mind by all frequenting these coasts:—

In consequence of several boats' crews having landed from shipping of various nations, on the open coast of Marocco, or West Barbary, in search, it is supposed, of water or other provisions, the Moorish authorities are desirous that all persons be cautioned that it is not only against the law of this land, and against the sanatory regulations, to land on any part of this coast, in places where there is not a port for its reception, but that, in consequence of the strict injunctions given to the people of this country by their government to prevent any persons whatever setting footing on land, or approaching near to it on the open coast, the lives of those who infringe the laws in such respect are exposed to danger.

The undersigned feels it, therefore, his duty to give all the publicity he can to this notice, for warning all commanders and masters of vessels, and especially those navigating under the flags of the United Kingdom of Great Britain and Ireland, not to venture, upon any account, to land, or to allow any person under their care or orders, to land or approach within gun shot of the coast of Marocco or West Barbary, excepting within the harbours of any of the well-known ports of this country.—E. W. Drummond Hay, *Consul.*

TANGIER.—The town of Tangier, anciently called *Tingis* and *Tingia*, which stands on the western side of the bay, is now a place of increasing importance in the export of grain, beans, hides, oxen, wool, &c. The great desideratum of the port of Tangier is a mole, there being no kind of pier either for the landing of goods or passengers. The old mole was destroyed by the English in 1683, and a new one opened in 1876. On the head of this a small fixed *red* light is shown at an elevation of 20 feet, said to be visible 3 miles off.

The bay affords convenient anchorage for vessels of all sizes, opposite to the town, in from 9 to 12 fathoms, sand; but it is to be observed that on the southern side there is a rocky ledge, the *Bourée Rocks*, bearing E. by S. ½ S. from Tangier Point, and S.W. by W. from Cape Malabata. This cape, in a line with Europa Point, Gibraltar, leads clear of the shoal, and the anchorage, therefore, lies with Gibraltar open of the cape. Ships moor to the N.W. and S.E., with the longest cable to the N.W.

On the South side of the bay is a high and pleasant-looking hill, and about the town is a wall and some fortifications. On the shoalest part of the ledge, before-mentioned, the depth is only 16 feet, and there are 5 fathoms, on rocky bottom close to it. It is about half a mile off the shore, and not more than 3 or 4 fathoms in length. Between it and the eastern shore are 10 fathoms of water, and at the distance of about 10 fathoms from it are 7 fathoms. On entering the bay with an easterly wind, you may borrow towards Point Malabata at pleasure. From the anchorage, in 8 fathoms, the North end of Gibraltar, open to Malabata Point, bears N.E. by E. ½ E.; the old bridge of Tangier, S. ¼ W.; the old tower of Malabata, E.S.E. ¾ E.; and the town of Tangier, N.W. by W. ¾ W., about 1½ mile distant. There is broken coral all over the bay, and ships should never lie with more cable out than is sufficient to keep them from driving. There is said to be a spot of clean ground, in 9½ fathoms, with the North part of Tangier town wall on with a white patch on Cape Spartel, bearing W.N.W. ¼ W., and the pleasant hill above-mentioned bearing from S.S.W to S.W. by S. Easterly or Levant winds cause a heavy swell to tumble into the bay.

It is high water, on full and change days, at $1^h\ 42^m$; the tide in the bay rises 5 to 8 feet; the flood sets to the westward till 12^h, but does not extend thus more than 1½ mile from the shore.

In all the extent between Cape Spartel and Cape Cantin (lat. 32° 32′) as shown on the chart there are regular soundings toward the shore. In this track there are no harbours of consequence; those which exist being nearly choked up with sand. On sailing along, the inland mountains may be seen at a great distance, covered with snow, even in April and May.

CAPE SPARTEL, the N.W. point of the state of Marocco, is situate in lat. 35° 47′ 40″; and long. 5° 56′ W. The cape, at a distance, appears like an island, and is so high as to be seen, in clear weather, at the distance of 15 or 16 leagues. The ground about the cape is quite clear, with the exception of some high rocks, steep-to. *The Lighthouse*, which is the first established on the coast of Marocco, is a well-built stone tower, 79 feet high, standing half a mile East of the cape, and showing a *fixed bright light* at an elevation of 312 feet.

Around the West side of the cape, and at about one-third of the whole height from the summit is a range of well-defined basaltic columns, appearing like a coronet. At the distance of 2 miles from shore are 98 fathoms, the bank immediately dropping to an unfathomable depth. To the southward of the cape the bank extends much further off, and there is excellent anchorage on a bottom of mud and sand, and shelter from easterly winds.

The following descriptions of the coast between the parallels of 36° and 28° (those of Cape Spartel and Cape Juba), we owe principally to the Survey of Lieutenants W. Arlett, in the *Ætna*, and H. Kellett, in the *Raven*, 1835-36; and to the notices of Mr. T. J. Evans, of H.M.S. *Dido*, 1837-38.

From Cape Spartel the direction of the coast is S.W. 20 miles to *Arzilla*, a small fortified town situate close to the shore, between which and Cape Spartel there is good anchorage all along with a easterly wind. The depths of water are regular, 10 to 15 fathoms, over a sandy bottom, at 1 or 2 miles off shore. The coast-line is a flat, sandy and shingly beach, rising to a fine grazing country in the interior.

The Roadstead of Jeremia, the usual anchorage near Cape Spartel, extends from it 8 or 10 miles to the S.W. The *Dido* anchored in the following positions in smooth water, and well sheltered from a strong Levanter, or easterly wind.

1st.—In 15 fathoms, sand and small shells, Cape Spartel bearing N.E. ½ N.; the town of Arzilla, S. by W. ¾ W.; extremity of land to the right, two points nearly in a line, S.W. by S. Distance to the nearest shore about 1½ mile; soundings very regular to a depth of 5 fathoms, at 2 cables' length from shore.

2nd.—In 13 fathoms, coral rock, gravel, and sand, Cape Spartel bearing N.E. ¾ N., centre of the town of Arzilla, S. ¼ E.; two bold and prominent points to the S.W. of the town, nearly in a line S.S.W. ½ W.

At the village of *Almadronis*, nearly midway between Cape Spartel and Arzilla, landing can be effected.

Four or five miles to the N.E. of Arzilla is the *Wed el Ayasha*, a small river, barred across the entrance, but reported to flow sufficiently strong for a good supply of water; and the distance to roll the casks, the boat being anchored clear of the surf, not above 50 yards. The preceding description shows how far caution may be required.

Twelve miles inland from Arzilla is the *Jibel Habib*, a range of mountains very conspicuous from the sea, the loftiest of which is 3,170 feet above the sea. *Jibel Hasan*, another peak in this range, more to the northward, is 2,270 feet high. Just to the North of the town of Arzilla is a castle in ruins; and date trees, which overtop the walls, are growing in the court. On the wall fronting the sea, which is strengthened by three towers, twenty guns are mounted. Under the southern angle of the wall is a well white-washed tomb. The country around is well wooded, and a quantity laid out in gardens. The population is supposed to exceed 600.

In the latitude of Arzilla the bank extends 12 miles from the land. Here is a mackarel fishery, on which twenty or thirty Spanish and Portuguese feluccas are employed. The method of taking the fish is by three hooks fastened together: the fisherman throws a handful of salt or sand into the water, to which the fish rise, and are immediately jigged with great dexterity. They are cleaned and salted on the spot.

From Arzilla the coast trends to S.W. ½ W., and at the distance of 4 miles the coast hills rise to the height of 734 feet: at 5 miles further is the *Haffa el Beida*, a remarkable white cliff, in the shape of a wedge, which rises to 308 feet above the sea, and presents the same form in all directions. It may be distinguished when five leagues off; but the best mark for the coast is the Peak of Fas, an insulated mountain, resembling a sugar-loaf, which stands S.S.E. [*S.E.* 2° *S.*] from off the entrance of Laraiche, next described.

LARAICHE or **El Araiche**, a picturesque ruin, is situate on the deep southern point of the River *Al Khos*, which here meanders through a rich and fertile valley; *Al Khos* signifies *the bow; El Araiche*, the *pleasure-garden*. The population of Laraiche in 1876 numbered about 5,000, of whom 4,000 were Mohammedans and 1,000 Jews. Wheat, barley, maize, beans and pease grow in the district. About 150 vessels visit the place during a year. Supplies are abundant, and there is a fine spring of water on the northern shore, very convenient for shipping.

View of Laraiche. A. *The Port.* B. *The Town.*

Vessels not drawing above 12 feet water can pass over the bar during spring tides, the average depth of water being 13 feet. The best anchorage is with the town between South and S.S.E. The mouth of the river, which appears very broad, is really very narrow at low water, and has then only 5 and 6 ft. water over it, but there is a rise and fall of 9 to 12 ft. Inside the water deepens 24 feet. A "pap," or rising point, on the North side of the river, is 201 ft. high above the sea. The best anchorage in the roads for vessels intending to enter the river is with the distant conical mountain, Fas, appearing in the centre of the entrance, 1 mile from the point, in 12 fathoms, sand.

Between Arzilla and Laraiche the ground is tolerably clean, but not very good, being coarse gravel, with 25 and 30 fathoms of water, at from 1 to 3 miles from shore. Before Laraiche the depth decreases, and there are only 4 fathoms at 2 cables' length from shore. In sailing along this coast, care must be taken not to advance too near, unless it should be with a strong easterly wind; for sometimes, in calm weather, there is here a heavy swell from the West or N.W., which would render it difficult to get off shore.

The site of *Old Mamora* is known by several whitewashed tombs, the chief of which is that of *Muley Bu Selham*, at the outlet of a stream said to flow from a small lake 20 miles to the southward of Laraiche. At 2 cables' length from the bar is a depth of 5 fathoms, gradually increasing to 34 at 2 miles from shore. The coast between Laraiche and this spot is straight, and for the most part about 300 feet in height; reddish cliffs for the first 10 miles, then sand-hills partly covered with brushwood. There are everywhere from 20 to 25 fathoms of water, at half a league from shore, and you may anchor off the coast hence to Sla or Sali. Ships, in fact, must sometimes anchor here, during a calm, to avoid being drifted by the currents, which set to the southward, along the coast; and the velocity of which, especially at the full and change of the moon, is frequently from 1 to 2 miles an hour.

The Peak of Fas, above mentioned, serves as a mark for Old Mamora, from which it bears nearly *true* East.

From this place the coast extends 10 leagues S.S.W to *Mahedia*. The coast is very clear, a little higher than the former, and readily known, being of white sand as far as about the middle of its declivity, while the upper part appears like cliffs. The River Sebou, on the South bank of which the town is situate, is impassable, except in boats, or on rafts, at some distance from the sea, although navigable near the ocean. The town extends from the seashore to the top of the highest land, so that you may

readily distinguish from the offing the walls of an old castle, situate in the upper part of it. Ships may anchor, at half a league, from shore, in 12 or 14 fathoms, sandy ground; but when the wind blows from the offing, and sometimes in fair weather, the swell is here very great, as well as along the coast. The best anchorage is with the town from S.E. by E. to S.E. by S.

Mahediyeh was formerly a place of some consequence, and is noted for the ruins of fountains, arches, &c. The town now contains only 300 to 400 inhabitants, chiefly fishermen, who subsist by the sale of *shebbel*, an excellent fish, much like salmon, which is caught here in great abundance.

In the summer the wind generally prevails from N. by E. to N.E. along the coast. During winter, there is a blustering S.W. and S.S.W. wind; and, in this season, when it begins to chop about to the South or S.E., shipping must get off, for then it commonly shifts to the S.W. and W.S.W. with foul weather. When it changes to W.N.W. or N.W., the weather is likely to be clear.

Between Mehedyeh and Sla or Sali, the coast is rather low, with double land, very even, with a white sandy strand, therefore readily known. At about half-way the strand rises, and thence, southward, the shore consists of black and steep rugged rocks, with small hills.

SLA and RABAT.—The towns of Sla and Rabat are divided by the river called the *Bu Regreb*. *Sla*, or *Sali*, says Captain Washington, once the terror of the seas, so renowned for its rovers, whose daring exploits reached even to our coasts; whose city and port were a constant scene of riot and bustle, and activity; now ruined, still, and lifeless. The present town, built on a sandy point, extending to the sea, forming the north-eastern bank of the river, is about half a mile in length by a quarter in breadth, surrounded by walls 30 feet high, and square towers every 50 paces. The mosques, arches, and fountains in the city show traces of beautiful sculpture, and of great antiquity. Streets narrow, and houses sombre, like all Moorish towns. Population about 10,000, of which 500 may be Jews. In the year 1876, 44 vessels entered, of which 23 were English. Export chiefly wool, grain, beans, &c.

The river is here about 500 yards broad when full. The bar, about one-eighth of a mile from the entrance, extends almost across in a W.S.W. direction, with 3 or 4 feet on it at low water, leaving a channel at each end; the Moors use the eastern. Rise of tide 9 or 10 feet. From the anchorage off-shore the water shoalens very gradually till close to the bar, where it suddenly drops from 7 to 2 fathoms. Here is almost invariably a heavy surf. Mr. Vice-Consul James Hay said, in 1865, that the bar can only be crossed by vessels drawing less than 8 feet water.

Rabat, on the S.W. side of the river, is 50 or 60 feet above its level, on banks of crumbling sandstone. It is crowned by a venerable and battlemented *Kasbah*, or citadel. A curtain of 500 yards, facing the sea, flanked by two circular batteries of twelve guns each, about as many more in the Kasbah, and a small battery overlooking the river at the S.W. end of the town, form its sea defences. The town is three-quarters of a mile long by one-third in breadth, and walled orchards of about 200 acres reach along the banks of the river.

A remarkable old tower at Rabat, called the tower of Beni Hassan, is the best seamark for this place. It is built of hewn stone, is 189 feet in height, 35 or 36 feet broad. At a small distance to the northward of it are the ruins of an ancient wall, on which were formerly a battery and castle.

The country in this neighbourhood is planted with vines, oranges, and cotton, of an excellent quality. There are docks for ship-building, both at Sla and Rabat.

The Road of Sla is dangerous for shipping, and the accumulation of sand at the entrance will scarcely permit a vessel of 100 tons to enter the river without danger. Vessels may lie in safety out of the river, near Rabat, from April to September inclusive; but they are not secure in the rest of the year, the wind blowing from the southern quarter, and often obliging them to quit their moorings. The best anchorage in this season is between the Mosque of Rabat and the old tower of Hassan, keeping the former to the northward. As a great number of anchors have been lost in the road, much attention must be paid to the cables. Mr. Vice-Consul Frost, in 1875, mentions the fact that, in 1875, many vessels coming here were unable to communicate, and a proposal was on foot for placing a hulk outside the bar for the reception of cargo when communication is impossible.

El Mansoria, shown on the chart, is a square of 150 paces, enclosing an Arab village. The tower of the mosque, 80 ft. high, stands 180 ft. above the sea, from which it is less than a mile distant, and may be visible at 6 leagues. The coast here is iron-bound and rocky.

Fidallah, a peninsula, frequently mistaken for an island, forms a harbour, having a depth of 5 or 6 fathoms, which affoods shelter to small vessels during westerly winds. A roadstead here is supposed to be the only one, with the exception of Agadi, in the parallel of 30° 27′, wherein ships on the coast may ride in security during winter. This is owing to a projection of the land South of the peninsula, above mentioned.

The village of Fidallah, situate at three-quarters of a mile from the sea, is a walled square, of about 200 paces, enclosing a respectable mosque, the ruins of European merchants' houses, and an Arab encampment. It may perhaps, contain 300 inhabitants—Moors, Arabs, and Jews.

Between Rabat and Point Fidallah there is no danger beyond a quarter of a mile from shore; the Bank of Soundings extends to the distance of 20 or 22 miles from the land, increasing south-westward. From 160 fathoms, mud, the water shoalens suddenly to 90 or 80 fathoms, between which depths and 60 fathoms it continues for many miles, sand and mud, decreasing to 30 fathoms at 3 miles from shore. The inland features vary slightly; two lines of barren and gently undulating hills, from 230 to 300 feet in height, extend nearly parallel to the coast; the more distant are from 4 to 6 miles from the sea, the nearer not more than a mile, sloping gradually to the beach, which is generallly sandy, with occasional patches of rock.

DAR EL BEIDA or Casa Blanca (both names meaning "White House"), lying at 4 leagues W. by S. from Fidallah, is a small walled town on the beach, within a point projecting half a mile N.N.E. *true*, and forming a cove, three-quarters of a mile deep, and well sheltered from westerly winds. This town, as well as Fidallah, was built for the exportation of corn. In 1876, beans, maize, and pease were exported to the value of £83,074. The

towers of three mosques are conspicuous, and one is of superior height. Around the town are many palm-trees and gardens; water is abundant.

This place is easily known by its towers, one of which seems almost as high as Hassan's Tower at Sali. The coast between is low, and bordered with small islets, all very near the land.

The anchorage is good at 1½ or 2 miles from the shore, where there is 15 to 17 fathoms water. Near the town there are reefs extending nearly a quarter of a mile from the shore, over which the surf is constantly breaking. Between the anchorage ground and the shore a good bottom is found; but in consequence of a strong current which sets in from the westward, you should anchor beyond its action.

The landing-place is a narrow entrance with a sandy bottom about forty yards wide, with reefs on either side, over which the surf breaks in almost all weather. In making for this entrance the shore boats, long before they approach, steer to windward, and afterwards shape their course for the inlet, aided by the current. Strong W. or N.W. winds stop communication with the shore.

AZAMOR.—On a sand-hill at about 13 leagues to the south-westward of Dar el Beida is the small town of Azamor, situate on the South side of the mouth of a river called the *Morbega*, or *Wad-oom-er-begh*. Its walls, crumbling to ruin, are tenanted by storks. The place is dull and lifeless; streets narrow and dirty; but provisions, fish, vegetables, and fruit, abundant and good. The population about 1,000, including Jews. These carry on a considerable trade in wool, which is shipped from Mazagan. The inhabitants of the country around, who are of superior stature, are chiefly pastoral, possessing large flocks of sheep and goats, and mostly live in tents. Wood is scarce and dear.

The bar of the river is dry at low water. The entrance is dangerous, and the shore flat, having not above 8 or 10 fathoms of water for 1 or 1½ leagues from shore, and foul rocky ground, so that it is not safe to anchor hereabout.

MAZAGAN.—From Azamor to the remains of the town of Mazagan, or Mazighan, on the S.W., the distance is 10 miles. This place is on a low rocky point, projecting to the N., which forms the western limit of a sandy cove, of about 1½ miles, and affording a good roadstead for small vessels. It is defended by several redoubts. Excellent water, and good supplies may be got. A large proportion of the buildings are used as store-houses for wool, beans, maize, &c. of which great quantities are hence exported. There is a tank, admirably constructed, which will contain several thousand tons of water. A lofty building, 140 feet high, now in ruins, appears to have been a lighthouse. There is anchorage off the coast, at a league from the shore, in 15 fathoms, sandy ground; but at the West point of Mazagan is a ledge of rocks, which stretch to the N.E. about a league into the sea, and are uncovered at low water. A dangerous patch of rocks, because the sea only breaks on them at low water in bad weather, lies 720 fathoms W.N.W. from the old light-tower. The best anchorage is to bring the two flagstaffs on the Sardinian consul's house in one, and anchor in 5 fathoms water; by doing so, you come upon a patch of blue clay, the rest of the bay being all rocky bottom without exception. The shore hence toward Capo Blanco North is everywhere rocky and dangerous, to a considerable distance from

it; and ships that stop here must anchor at 2 leagues off, in 35 or 36 fathoms of water, oazy ground. The swell is almost always very great, and the current is very strong. From Mazagan to Port Blanco the distance is 4 leagues. The shore between is merely a ridge of sandhills. About midway are the ruins of *Tett*, or *Tid*, an ancient town, and a conspicuous tower, 128 feet high, and 118 feet above the sea, which may therefore be seen from a great distance. Two large tombs, kept whitewashed, stand on either side of it.

The coast hereabout should not be approached nearer than 1½ mile, as scattered rocks lie off the shore, and the bottom is very uneven. The beach, in some places sandy, is generally lined with craggy rocks. A line of barren hills, 200 ft. high, slope to the beach along the whole distance, and terminate just to the northward of the cape in a low and dark but abrupt and rocky cliff.

CAPE BLANCO North.—This is in lat. 33° 8′, a little to the southward of the headland last mentioned. It is 170 ft. high, appears to be of white sandstone, and the lines of strata, white and red, rising parallel to the horizon for some distance, suddenly drop at nearly a right angle to the water, and the cliff appears like a wall. In a bight on the S.W., which is formed by the cape, is a good anchoring place of sufficient extent for several ships.

At 22 miles westward of Cape Blanco are soundings of 150 fathoms, fine sand, gradually decreasing to 28 fathoms at 4 miles from the shore.

A dark and rather projecting cliff, formerly represented as an islet, under the name of *Duksal*, stands at about 4 miles southward from Cape Blanco; and, at 6 miles from the cape, hills rise gradually from the beach to the height of 465 ft., the greatest elevation on the western shore of Marocco. Hereabout are the ruins of *Woladia*, where it seems there was once a harbour. At 4 and 7 miles to the southward of these, on the edge of the cliff, are those of two other small towns, supposed to be Eder and Teturia.

CAPE CANTIN, or **Ras al Hudik** (Cape of Palm Groves), in lat. 32° 32½′, is a steep headland, which rises precipitously to 211 ft. above the sea, and has a ledge of rocks projecting from it; on its summit is a small sepulchre. At 16 miles westward from the cape are soundings of 100 fathoms, fine sand; this depth gradually decreases eastward.

From the preceding description it will appear, that between Cape Blanco and Cape North the coast is much bigger than the coast between Cape Blanco and Laraiche. It trends to the S. by W. ½ W. 21½ leagues, and is safe all along, having only some small islets very near the land. At 2 leagues off the depths are 40 and 50 fathoms, oazy ground. The currents are very strong, and generally run in the direction of the coast, S.W. by S.

From Cape Cantin to the North point of *Asfee*, or *Safi Bay*, the coast trends S.S.W. (*nearly South*) 4 leagues, and is much higher than the coast already described. Between these points, at the distance of a league from shore, is a rocky bank extending North and South, *true*, having over it from 30 to 40 fathoms, and at times abounding with fish. From the North point of the bay (which is foul) to the town of Asfee, or Safi, the distance to the S.S.E. is 2½ leagues.

Safi, Saffe, or Asafi.—The North cape of the Bay of Safi forms two headlands; on the southern one is a tomb, or sanctuary. The coast between Cape Cantin and the bay is one continued white cliff, with a sandy beach at its base; the cliff, rising gradually to its southern projection, is there 530 feet in height, and here the bay commences. In the bight within is a ravine, the bed of a winter torrent; and on the slope stands the ancient town of Safi, in lat. 32° 18′ or 32° 19′, between two hills, which render it intolerably hot; and, in winter, very disagreeable, as the waters from the neighbouring mountains, occasioned by the rains, discharge themselves through the main street into the sea. The road is safe in summer; but in winter, when the wind is from S. or S.W., vessels are frequently obliged to make off to sea.

Safi is a considerable town, surrounded by a wall 31 ft. high, with a ditch, and defended by 24 heavy guns, next to the sea. The tower of one mosque is 209 ft. above the surface. Fresh water is scarce, and procured from wells southward of the town. The country in the immediate vicinity appears sandy and barren; but the interior abounds in corn, and two falls of rain in a year are said to be sufficient to bring it to maturity.

During the summer months, or from March to October, the bay affords as good anchorage, and smoother water, than any other on the coast, but is entirely exposed to westerly winds; the bottom is of sand and mud, and there is generally a depth of about 15 fathoms at a mile from shore. Vessels may anchor at a league from the town, in 20 or 22 fathoms of water, gray and oazy sand. To anchor in the road, the North point, on which stands a low tower, must be brought a little to the northward of N.N.E. Or, farther in the bay, the same point may be brought North (by compass) a little easterly, when the northernmost of the northern points will appear about a ship's length open, without the southernmost; and the high castle of the town S.E. by E. or S.E.; the depths 14 to 18 fathoms, fine gray sand. There is also anchorage within, in 15 fathoms, with the North Point N.N.W. or N. by W.; but these are the summer roads; in the winter, you must anchor farther from the land, in 20 or 22 fathoms, as already shown. You may boldly run in to the summer roads by night, with the castle bearing E. by S. or East.

If bound to *Safi*, from the northward, shape such a course as will lead sufficiently to the westward of Cape Cantin, in order to avoid the rocks about that cape. You may easily know on which side of Safi you are standing, as the land to the northward of the bay is high and uneven, and that to the southward of it is plain, even land.

From the South point of Safi Bay, which is very low, to the mouth of the *Wad Tansift*, or River of Marocco, the coast trends S.S.W. $\frac{3}{4}$ W. 16 miles, and presents, generally, a line of sand-hills, from 140 to 200 ft. high, which, in some places, terminate in low cliffs, and in others slope to the beach. Inland is a ridge of sandy-looking hills, covered with brushwood, the highest 650 ft. above the sea. There is a large tank on shore, nearly midway between Safi and the Tansift, and on the southern bank of the river is an old castellated building, square and roofless, which was built for the use of travellers. The Bar of the Tansift, although a considerable river, is in summer entirely dry at low water.

From the Tansift the coast extends in the direction of S.W. by W. $\frac{1}{2}$ W.,

to a low sandy point, forming a cove to the northward of it, with rocks within half a mile from the beach. The coast, which from the Tansift is barren and uncultivated, is from 200 to 300 ft. in height, here assumes features of fertility. The lofty *Jibel Hadid*, or *Iron Mountains*, extending more than 20 miles, is a mass of high land, which here rises to the height of 2,350 ft.; another, nearer the sea, with a conspicuous tomb on its summit, rises to 2,100 ft.

A sandy beach continues from the reef point nearly S.W., 12 miles, to Mogador; the inland prospect is here bounded by the *Botof* sand-hills, which extend parallel to the beach, at the distance of a mile.

MOGADOR, Suerrah, or *Suirra*, exports almonds, esparto, beans, goat-skins, gums, olive oil, orchilla weed, ostrich feathers, bees-wax, &c. In the year 1877, 40,289 tons of shipping entered the port, of which 9,327 was British and 24,076 French. The population of Mogador numbers 14,000 to 16,000 inhabitants, of which 4,000 are Jews. The town is built on a low flat desert of accumulating sand, which separates it from the cultivated country, and is defended from the encroachment of the sea by rocks, which extend from the northern to the southern gate, though, at spring tides, it is almost surrounded by water. There are two towns, or rather a citadel, and an outer town. Those Jews who are not foreign merchants, are obliged to reside in the latter, which is walled in, and protected by cannon as well as the citadel.

An island, which lies to the S.W. of the town, forms the harbour. This island is about $1\frac{1}{2}$ mile in circumference; and between it and the main land, on the South, is the anchorage. There are here, in some parts, only 12 ft. at low water; therefore large ships do not enter the port, but anchor at about $1\frac{1}{2}$ mile westward of the Skala, or long battery, which extends along the West side of the town toward the sea.

On approaching the land in the parallel of Mogador, the first remarkable feature which appears, is the craggy summit of Mount Atlas, covered with snow, and contrasting with the dark ridge of hills between it and the coast. To the northward the Jibel Hadid appears insulated, and, as you draw nearer, a long patch of sand becomes visible; and finally, the white towers of Mogador rise, as it were, from the water. Soundings, in 100 fathoms, may be found at 23 miles from shore, when the water immediately becomes discoloured; the soundings decrease very gradually, over a bottom of sand.

Mogador has a beautiful appearance at a distance from the sea, the houses being all of stone, and white. The streets are, nevertheless, narrow and dull. A winter seldom passes but some ships are driven ashore by the S.W. winds; and this happens generally between the 8th of December and the 18th of January, the season called *Liali* by the Arabs, and the only period dangerous for shipping in the bay.

The want of water has been diminished, by the construction of an aqueduct, which conveys the stream from the river, $1\frac{1}{4}$ mile distant to several large tanks in different parts of the town. A watering-place is constructed near the landing-place of the port, where vessels can water from, at high water, with great facility. The market is excellent; provisions of all sorts, including fish, poultry, and game, are abundant and cheap; as are, also, fruit and vegetables.

The position of the British Consul's house, as given by Lieut. Arlett, is 21° 30′ 29″ N., and 9° 46′ 0″ W. Capt. Boteler makes the longitude 9° 44′. From the roof of this house, the highest snowy peak of Atlas is seen, bearing S. 45° E.

The roadstead, during the winter, can scarcely be considered tenable; and even in the summer, the strong N.E. winds which prevail cause a very disagreeable sea. A westerly wind throws a very heavy swell into the harbour; but, notwithstanding reports which prevail to the contrary, it is not generally unsafe for vessels properly found in cables and anchors. "A steamvessel may always consider herself safe, taking the precaution if she is inside, to have two anchors down, one N.W., the other S.W., and having the engines ready to assist the cables."—*Annuario de Madrid*, 1865.

The North Passage into the harbour, which is 2½ cables across, is between the town and island. A ledge of rocks extends from the main, among which those next to the island stand high above water. In coming from the northward, if you would sail in behind the island, you must run between it and those rocks, close by them, where you will have 5 fathoms of water. The best anchorage is under the island, in 2½ fathoms, as there the ground is good.

South Passage.—A small reef extends from the South end of the island, toward the main land; and on the South side of the passage a bank extends from the main land to a considerable distance. The channel is tortuous, and has only from 3 to 3½ fathoms at low water. In sailing outward, run along by the latter, and you will soon be in 4, and thence to 10, fathoms of water. The tide flows here, on the full and change, at 4ʰ, and rises from 10 to 12 ft. The current is scarcely perceptible.

When the town was attacked by the French squadron under the Prince de Joinville, August 15-16, 1844, a survey was made of the place by Lieut. J. A. Prouhet, and the marks he gives for entering by the North Passage, is to bring the three central towers, or portions of the Emperor's house (which stands about 1¾ mile due South of the town), in line, or rather the two to the S.E., just open of that to the N.W. pavilion.

To leave the anchorage, run towards Cape Sem, until the two northernmost pavilions come in line about E. by S. *true*, when bear away to the westward, keeping them in one till well past the island.

At 8½ miles S.W. from Mogador lies *Ras Tagrifelt*, or *Cape Sem*, a low sandy point, sloping gradually from the height of 490 feet, and terminating in a reef of rocks which extend, on all sides, to the distance of rather more than two-thirds of a mile. The coast between this and Mogador is a continuous line of bare sand-hills, 70 ft. high, and sloping to the beach. In the background are the *Botof* sand-hills, covered with a dark evergreen. Under the cape is said to be a rocky bank, stretching 2 leagues off, and upon which, at a league from shore, has been found 13 fathoms; at 2 leagues, 20 fathoms, rocky ground; at 3 or 4 leagues, 35 and 40 fathoms, oazy sand. Hereabout the current sets violently to the southward.

Cape Tefelneh.—Cape Tefelneh, at 18½ miles S.S.W. from Cape Sem, rises to the height of 780 ft., and terminates in a point from which a ledge of rocks extends half a mile, with deep water close to them. There is anchoring ground under it, on the South, affording shelter from East and

N.E. winds, in 10 fathoms, sand. At 8 miles to the northward of Cape Tefelneh is *Kuleihat*, a small village on the side of a wooded hill. A little stream, *Tidsi*, falls into the sea at its foot, through a picturesque ravine; between these, high cliffs, apparently of sandstone, face the sea.

CAPE GHIR, or Geer (properly *Ras Aferni*), is situate, according to Lieut. Arlett, in lat. 30° 37′ 30″, and long. 9° 52′ 30″, and projects boldly into the sea at 25 miles to the southward from Cape Tefelneh. The intermediate back land rises to the height of 2,895 ft. above the sea; the country appears wooded, and numerous villages and tombs may be seen. On approaching Cape Ghir from the westward, it presents a bold bluff slope on each side, the highest part 1,235 ft. above the sea. The depths of water gradually diminish, and soundings are found at 26 miles off. The coast between Cape Tefelneh and Cape Ghir is a sandy beach. Cape Ghir is very remarkable, and may be seen when 4 leagues off. To the northward of the cape, about 4 miles within land, stands a round hummock, which is a mark for the cape, and the land farther to the northward is still higher; but on approaching the cape no land will be seen to the southward of it. From the North side of the cape a reef extends to some distance out to sea, and should not be approached nearer than in 20 fathoms of water.

AGADIR, or Santa Cruz.—The town of Agadir, or Santa Cruz, stands at 6 leagues south-eastward of Cape Ghir, at the bottom of the bay of the same name. This is the last port of Marocco in the Atlantic Ocean. The ruins of the town, called by the Portuguese *Fonté*, remain at the foot of the mountain; and the arms of that nation are yet to be seen in a building erected over the spring.

The bay is considered as the best road for vessels on the coast of Marocco, being large and well sheltered. It abounds in fish, immense quantities of which are caught by the inhabitants of the town. Owing to the jealousy of its government, Agadir has ceased to be a place of trade; yet it was formerly the centre of a very extensive commerce, whither the Arabs, and the people of Soudan, resorted to purchase merchandise for the markets of the interior of Africa; and caravans were constantly passing to and from Timbuctoo.

From the northward high barren hills slope to the beach, which is rocky, to the distance of 5 miles N.W. of Agadir, where a streamlet, the *Wad Tamarect*, flowing through a green valley, discharges itself into the sea. The high land, extending from Cape Ghir to Agadir, usually called the *Heights of Idantenau*, is the western extremity of the main chain of the Atlas, which ranges hence in an E.N.E. direction, and rises at 9 miles eastward of Agadir, to the height of 4,408 ft., and a remarkable conical hill, 3,980 ft.

At 6 or 7 miles to the N.W. of Agadir, above a point stretching into the bay, is a good anchoring place, with from 20 to 12 fathoms. In sailing from the cape to the road, be sure to run along by the land of the cape till you are before the castle, because northerly winds are very prevalent here; and should you keep too far from shore, you may be forced to fetch it up again with difficulty. If coming in by night, approach no nearer than in 12 or 14 fathoms.

To anchor in the Road of Agadir, enter the bay so far that the castle

may bear N.N.E., and the storehouses E.N.E. Here you will be to the southward of a rocky ledge, lying off the town, in 7 or 8 fathoms of water. The best riding is with Cape Ghir bearing North, in 6 or 7 fathoms. Care must be taken to have your anchors ready; your small bower is always to be laid out before the land-wind, and the others to seaward; the sheet-anchor must also be in readiness, and brought out to the S.W. against a storm, which is soon perceived by the rising and swelling of the sea. It is likewise necessary to keep the foresail to the yard, that you may defend yourself the better, should you happen to be driven from your anchors.

From Agadir southward the authority of Marocco lessens, and the Wedinoons proudly boast their independence.

Immediately to the southward of Agadir a very low and flat country commences, and extends thence 29 miles. At 5 miles to the southward of Agadir is the mouth of the *Suse*, a fine river, rising at the base of the Atlas; but the bar is dry at low water, and can never be passed by vessels drawing more than 4 or 5 ft.* From the Suse the coast southward continues sandy. The *Wad Messa*, about 30 miles from the Suse, has, likewise, a bar dry at low water, but may have 4 or 5 ft. over it at high water, spring tides. At a short distance within this, on the North side, is a village; and near the beach, on the South, is a castellated building.

At a few miles to the northward of the Messa are the wells called *Tomie*, or the Seven Wells, off which is an open roadstead. On this parallel, about 30° 0′, is a depth of 86 fathoms, dark sand, at 16 miles from shore; and 45 fathoms, sand and mud, at 5 miles from the same, decreasing thence gradually to the beach.

Cape Aguluh of the charts is only a slight rounding of the coast, in lat. 29° 49′, long. 9° 48′.† From the Messa southward the beach still continues sandy, but verdant hills, approaching the sea, break off into cliffs, apparently of sandstone, about 100 ft. in height. In the interior is a ridge of high mountains, at 50 or 60 miles from the coast. The interval between appears like a wooded and well-cultivated country, with many houses and farm buildings. Immediately to the southward of the cape is a little sandy bay, and a valley crossed by a hill, on which stands the village of Aguluh. A small stream runs down the valley. The slopes of the hills were waving with corn, nearly ripe, in May, 1835. At half a day's journey (by land) South of the Messa is a small town, called by Mr. Elton, Seed Bom Noire, where there is a small harbour.

At 12 miles to the southward of Aguluh, the features of the country change; the hills become barren and abrupt, and form in successive ridges, gradually increasing in height till they join the line of distant mountains, which rise to the height of nearly 4,000 ft., and appear to be the S.W. extremity of an off-set of the Atlas. More to the southward the appearance of the inland country continues the same, but the coast changes to dark

* Mr. W. J. Elton, Vice-Consul at Mogador, says that the depth in the mouth of the Suse and of the Messa (Massa) is 12 feet at high, and 2 feet at low, water.

† Where the Messa has commonly been represented. The latter, we presume, is in lat. 29° 56′ or thereabout.—Ed.

red cliffs, broken into coves, on the beaches of which boats may be seen; and there are many villages, but inhabited by people of perfidious character.

In lat. 29° 22′, is a remarkable white cliff, supposed to be of limestone, and described by Lieut. Arlett as follows:—It strata are extremely curved and irregular, and it forms a good mark for the coast; behind it, and standing alone, is a conical shaped mountain, rising to the height of 3,906 feet. In this latitude, at 25 miles from shore, are soundings in 105 fathoms, broken shells; outside of this the bank drops very suddenly. On standing in-shore the soundings decrease rapidly to 60 fathoms. At 5 miles from shore are 28 fathoms, coarse sand; the depth thence decreases very gradually to the beach. From the cliff above described the country assumes a more rugged and barren appearance; the hills steep, with deep and narrow ravines; the coast, alternate hills and sandy bays, with prominences rocky and rugged.

In 29° 10′ N. is a cove, marked on the charts *Reguala* or *Gueder*. A rocky prominence on each side projects to a short distance; the sides are steep and barren; these are separated by a deep and narrow ravine, down which a slender stream finds its way to the sea. In this cove the water is deep, and bottom clean to the beach; a landing may generally be effected in it, but it affords no shelter.

In lat. 29° 3′ the mountainous country terminates, and a sandy desert commences. There is also a break in the coast, which seems to be the dry bed of a river, and is called by the Canarians *Rio de Playa Blanca*, or White Beach River. At 4 miles to the southward of this the coast is of bold sandstone cliffs, with sand-downs in the interior devoid of herbage, and thus it continues to Cape Noon, in lat. 28° 45′ 45″, as shown in page 32.

Cape Noon presents a cliff of sandstone 170 ft. above the sea; but owing to the cliffs to some distance on each side being of the same height, and the country inland a flat desert, it is difficult to make out the exact projection till very near it. The cape is steep-to, and clear of danger.

Here the depth gradually increases outward; and at the distance of 4 miles from shore the depths are from 30 to 54 fathoms, bottom of reddish sand; at 12 miles, 57 fathoms, dark sand; and at 30 miles, 98 fathoms, coarse red sand; the water then deepens very suddenly. For a long distance, both to the northward and southward of the cape, as well as to seaward, the water is very much discoloured. It has a red tinge, and is so thick that the track of a ship is visible for a length of time. At 4 miles to the south-westward of Cape Noon is the *River Shleema* (the Akassa of the charts); and at 31 miles more, in the same direction, is the Akassa, in lat. 28° 19′. (This must be the Inoon of the Chevalier de Borda, given in page 32.) Each river has a bar, but both appear to have deep water inside, and the banks of both are verdant and fringed with shrubs.

The Shleema, when well open, may be recognised by two remarkable hills, which will then appear in the centre of the gap. They are conical; and on one of them, 325 feet high, are some ruins, said to be those of a fortress. The coast between Cape Noon and the Shleema affords secure anchorage, with moderate depth of water, from the month of March to October.

WEDINOON, or **Noon**, is a kind of intermediate depôt for merchandise on its way to Soudan, and for the produce of Soudan going to Mogador. Gums and wax are produced here.

The coast line between the Shleema and Akassa (or Inoon) is a continued sandstone cliff. A table-land, about 900 ft. high, at 3 miles from the shore, shows just above the cliffs, near which there is a regular depth of 20 fathoms, with good ground. On approaching, the table-land appears to break into detached hills, one of which, 950 ft. high, and more insulated than the others, serves to identify the river.

The *Fishery* carried on by the people of the Canaries commences near the parallel of Cape Noon, the fishermen seldom venturing to the northward, although fish are equally abundant, from their dread of the Moors, who on that part of the coast, possess boats. From the cape to the Bank of Arguin (an extent of 200 leagues) the inhabitants of the desert have not a single boat. The fishermen frequently land, not only to procure water, but to barter their fish for wood and orchilla; on these occasions great precautions are taken, as atrocities have frequently been perpetrated on both sides.

Porto Cansado.—From the River Akassa (Inoon of Borda?) the coast and country continue as described above. The cliffs are above 120 ft. in height to lat. 28° 7′, or to Porto Cansado of the charts. Here the cliffs terminate, and a low sandy beach begins, continuing in a S.W. direction 18 miles, to lat. 28° 2′, long. 12° 14′, where there is the entrance of the *Porto Cansado* of the Portuguese, which is described in the Narrative of Judah Paddock. The entrance of this harbour is narrow, widening inside, and forming a sort of lagoon. The sea breaks heavily across, and at times it is barely possible that boats may enter. Its only distinguishing mark is a table hill, 580 feet high above the sea.

From Porto Cansado the coast trends westward to *Cape Juby*, in 12° 55″ W. At a short distance to the westward of Porto Cansado, a cliff, from 90 to 100 feet in height, again commences, and continues for 17 miles. The cliff is of dark sandstone, and the bottom, being also of dark sand, gives a green appearance to the water. A flat desert extends inland as far as the eye can reach. There is no beach, the sea breaking against the cliffs, on which it appears to be encroaching. Where the cliffs terminate, the land becomes broken into sand-hills partly covered with bushes, and the coast trends in a *true* direction S. 80° W. to Cape Juby, 15 or 16 miles.

Cape Juby is a low sandy point; near its extremity is a hummock, covered with bushes, appearing like an islet. Rocks extend from the cape to one-third of a mile. Here the coast changes abruptly to S.W. (*true*), and forms some coves, off the points of which are scattered rocks. From Cape Noon to Cape Juby the bank of soundings extends to an equal distance, and the depth increases very gradually to the shore.

Currents along Shore.—During five months (from March to August), the time occupied by the *Ætna* and *Raven*, in the survey of the coast, a distance of 750 miles, no day passed in which the former was not at least twelve hours at anchor, usually at the distance of from 4 to 5 miles from shore, and in positions well adapted for making observations on the currents, which were constantly attended to. Independently of this, the *Raven* was repeatedly sent to the distance of 20 and 30 miles from land; particularly

when fixed and conspicuous objects afforded opportunities for ascertaining her exact position; by comparing which with that which should have been given by the course steered, the rate and direction of the current could be ascertained to a considerable degree of exactness.

From Cape Spartel, along the coast, to Arzilla, and also to the distance of 7 or 8 miles from the shore, a regular tide was experienced, running parallel to the coast; but its strength was rather greater to the northward than to the southward. In this distance, at 15 miles from land, no tide or current was perceptible.

From Arzilla, southerly, a tide was still experienced, gradually diminishing in strength till its direction could not be ascertained. From the parallel of 34° 30′ N. to the distance of 20 miles in the offing, a steady southerly set was first experienced. This current, in the offing, continues invariably to follow the direction of the land; its velocity increasing or diminishing from the rate of four-tenths to 1 mile an hour, according to the strength or duration of the north-easterly winds.

From Mogador to Cape Boiador, except in particular instances, the current continues invariably to run in the direction of the coast. Its greatest strength is usually at the distance of from 3 to 6 miles from the land, gradually decreasing on receding from it. Its average rate between 31½° to 28° N. is from one-half to three-quarters of a mile in the hour. At Cape Juby, probably from its stream being in some measure confined by the projecting cape, and perhaps by the Canary Islands (distant 58 miles) it increases its rate to 1¼ mile, but diminishes off Cape Bojador to 1 mile. It did not appear that this current was influenced by any particular wind, but near the shore a tide was generally perceived.—(See remarks on the currents on pages 334—338.)

Shipwrecks.—The various tribes of Arabs frequenting the coast of the desert, have already been alluded to, as well as the danger of falling into their power. Their practice has been, when a ship is stranded, and the crew compelled to surrender, to take everything portable from the vessel in boats; and then, if the sea do not dash it in pieces, they set fire to it, that it may not serve as a warning to other ships which may be so unfortunate as to follow the same course.

The tropical regions of the African coast between Cape Boiador and Cape Blanco, present to contemplation the *Sahara*, considered as the most extensive desert on the globe. This desert consists of inadhesive sands, which are driven about by the winds, and chiefly by those from N.E., by which they are disturbed and carried to an astonishing distance.

This question of the red dust, which falls in the open air, is more amply discussed hereafter. The few remarks which follow will suffice here.

Of the merchant-fleet from St. Helena, under convoy, in November, 1813, most of the ships had their sails covered with *red* sand, and they must have been from 400 to 500 miles from shore, in about 27° and 28° N., after a

succession of easterly winds. "I once," says Mr. Luccock, "saw the sails and deck of a vessel covered with it, when 400 miles from the coast, and have heard of the same phenomenon being remarked at a far greater distance. This moving expanse of sand was probably, at some anterior period, a large inland shallow sea, communicating with the Mediterranean by the Syrtes [Gulf of Sydra], &c."

A similar phenomenon occurred to the brig *Parssboro'*, on her voyage from Barbados to Belfast, and when she was upwards of 900 miles from the main land of Africa. The wind, it will be observed, had been at East, and was interrupted by one of those gales which will be noticed hereafter, in our description of the Azores. In lat. 30° 50′ N., long. 32° 40′, Cape de Verde Islands bearing S.E., distant 590 miles, the appearance of a heavy squall rising in the S.E. direction. Half-past six p.m., lightning, thunder, and the squall approaching nearer. At thirty minutes past six p.m., the sun about 15° above the western horizon, became overcast with peculiar looking clouds, and every appearance of an approaching storm. I consequently shortened sail, although the barometer did not indicate anything serious. At eight p.m., the wind became very variable, from N.E. to S.W., every ten or fifteen minutes alternately, for two hours. There was a fall of rain when the heaviest of the squall was on the zenith. At midnight it had all passed to the S.W., and the wind resumed its former place, East. At daylight, *the decks, rigging, spars, and paint work were covered with mud:* and as the sun dried it, it had the appearance of a very fine red mould, with no sand in it.

CAPE BOIADOR* is in lat. 26° 7′. The cape has some rocks about it, but on its South side is a bay affording anchorage in 4 or 5 fathoms, and ships may anchor further out in from 15 to 20 fathoms, within a league of the shore, on a bottom of sand, broken shells &c.

The Baron Roussin says, that the coast to the northward of Cape Boiador is similar to that of the desert to which it belongs. It is arid and sandy, the only signs of vegetation being a few small tufts of dried brambles, scattered promiscuously here and there. It presents no other variety than some flat downs of a tabular form, whose base can scarcely be seen at the distance of 3 miles from the beach. The nature of its soil is exclusively siliceous, being sand without any mixture whatever. The surface of this plain is so completely horizontal, that it actually appears to have been levelled. In some places on the coast it terminates in a steep cliff, and in others in a gentle descent toward the sea. These cliffs are streaked with horizontal beds of different shades, approaching to white; the lower ones being generally thinner, and of a more reddish cast than the upper. To the northward of the parallel of 23° N., this soil is overspread with a crust of black earth, which, from its being nearly general, may be taken as its covering, and is of a tolerable thickness. This species of crust, no doubt, derives its consistency from the great humidity which it contracts during the rainy season, and the extreme heat to which it is again suddenly and constantly exposed.

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* Cape Boiador, or properly *Boyador*, was the limit of Portuguese knowledge up to the year 1435. Beyond it was the "Sea of Darkness," which they feared to penetrate, but in the year named, Alfonso Gonçalves de Balday rounded it. See Major's "Life of Prince Henry the Navigator, pages 85, 133, &c.

By the repeated shocks of the sea, huge masses of this black crust fall to the bottom of the cliffs, and relieve the sameness of the shore. They first resemble rocks on which the sea breaks, but their corners are soon worn away, and they present but a heap of sand. On the whole extent of the coast, as far as Cape Verde, there is not a single piece of granite. Cape Boiador, which lies in 26° 7′ N., and 14° 34′ 34″ W., is not very remarkable. When seen from the northward, it presents a strand of red sand, having a gradual descent towards the sea; and its western extremity, which is very low, forms a small bay with the cliff which immediately follows. The position here given is that of the easternmost point of the cliff, which has been selected as the most remarkable one in the neighbourhood; its height being about 70 ft. The depth along the coast, 3 or 4 miles to the northward of Cape Boiador, varies from 12 to 20 fathoms, increasing gradually toward the parallel of the cape. The nature of the bottom throughout is of sand and broken shells, or of sand and gravel. At the distance of 2 leagues to the seaward there are 25 fathoms of water; and the sandy bottom becomes more general—a circumstance which is common to all the African coast.

In 1876 Mr. Donald Mackenzie was on this coast surveying between Cape Juby and Cape Bojador, with the purpose of finding out the possibility of opening up a water communication with the interior by means of canals, or by flooding the desert with sea water. We have no results of this expedition.

It is possible to anchor in the small bay of Cape Boiador, but the bottom is foul. At the distance of half a mile from the shore there are 13 or 14 fathoms of water.

From *Cape Boiador* the coast trends S.W. ½ S. about 22 leagues, to a very remarkable cliff, about 300 ft. high. The cliff seems to be the *Penha Grandé*, or *Great Rock* of the charts. As its height considerably exceeds that of any spot in the vicinity, it may serve as a good land-mark.

All the coast thus far presents, alternately, cliffs and sandy beaches; but more particularly the former. It is from 150 to 200 ft. in height; being flat at its summit. The land in the interior, on which brushwood is very scarce, is of a darkish colour.

The depth of water on this part of the coast is considerable. At 2 miles from the beach, bottom cannot be found at 22 fathoms. On the parallel of 25° 50′ N., and at 1½ mile from the shore, bottom may be had in 15 or 20 fathoms, gravel and broken shells. The depth again increases; and under the Penha Grandé, at a mile from the foot of the cliff, there are 26 fathoms, hard bottom, with gravel and broken shells. The summit of the Penha Grandé is in 25° 7′ 6″ N., and 14° 50′ 53″ W.; it is flat and arid; all its declivities are precipices from broken earth, which has fallen down, the colour of which is gray. The whole of the coast is perfectly clean, even to the beach.

From the *Penha Grandé*, after a slight indentation, the coast trends S.S.W. ¼ W. 8 leagues, and includes a slender bay, now called the *Garnet Bay*. It then forms a well-defined elbow, and trends nearly S.W. by W. ¾ W. 29 leagues. On all this extent it presents one continued cliff, with the exception of two or three places, where it slopes to the sea; the cliff being about 150 ft. high. Frequently, at a short distance from the water's edge,

between the cliff and the sandy rocks which here cover the beach, there is a chain of white sandy downs. The summit of the cliff is even and horizontal; it follows nearly a right line, interrupted only by some small flat downs, scarcely perceptible. The whole of the beach is continually washed by an exceedingly heavy surf, and there is no sign of vegetation on the whole coast.

Garnet Bay (or *Gurnard Bay*), which is the *Angra dos Ruivos* discovered by the Portuguese, sent out by Prince Henry in 1435, abounds with cod, bream, hake, and various kind of other fish. Two leagues to the southward of it are seven small table-hills, called the *Seven Capes*, which constitute an excellent land-mark.

From the elbow formed by the coast, on the South side of Garnet Bay, to the south-westward, the depth diminishes a little; from 16 fathoms it gradually lessens to 11 fathoms, and continues nearly the same in a space of 6 miles. We shall now have arrived at the parallel of 24° N., and immediately abreast of an interruption in the cliff, at a beach of white sand, about a league in extent. Beyond this sand, which does not reach far into the interior, is a body of still water, having the appearance of a lake or river, with a sandy islet in the middle of it. This is the upper part of an inlet, named *Rio do Ouro*, or *Gold River*.

Continuing a south-westerly course, along a neck of sand, which separates the river from the ocean, and which is alternately interspersed with cliffs, after running 10 leagues from where it was first observed, we arrive at its entrance. In this run, at the distance of 1 to 3 miles from the shore, the soundings vary from 16 to 8 fathoms, with a hard bottom and shells. On approaching the river, white sand will be found.

RIO OURO.—The entrance of this inlet is in 23° 36′ N., and 15° 58½′ W. Its breadth, taken from the outer cliff on the West bank, to the cliff on the bend of the coast forming the East bank, is 7½ miles; but a very low, sandy point stretches to the southward, from the West bank, in such a manner as to leave only a free channel of a mile in width at the utmost.

Neither to the northward, nor at the entrance of this channel, does any island exist, although the old charts mark several; but at 20 miles to the N.E. of the northern point of the entrance, and on the meridian of the islet, in the interior before mentioned, there is a cliffy mound of sand, which, being insulated on a low sandy flat, might have been mistaken for an islet. This, however, forms a part of the bank with which it is connected at its southern point.

No particular current was observed off the Rio Ouro, which consequently does away with the composition of a river emptying itself by this opening. At the distance of about 3 miles seaward from the mouth of the inlet, the bottom is of sand and shells, with a depth varying from 9 to 16½ fathoms. In the middle of its entrance is a circular breaker, 1 mile in diameter, on which there appears to be very little water. The northern point is wholly surrounded by breakers, but they are only a continuation of the surf which is found on the whole coast. The adjoining sea is well stocked with fish.

From the southern point of the River Ouro, the coast trends nearly S.W. ¼ S. (*S.S.W.*) The cliff continues to a distance of 5 leagues, when white sandy downs succeed, of which the summits are mostly flat. At 1

league northward (*N.N.W.*) from the extremity of the cliffs, and at 3 miles from the coast there is a bank, having only 32 ft. of water; its direction is parallel to that of the coast, and it is about 2 miles in length. Thirteen fathoms have been found on the edge of this bank; to the northward of it the bottom is sand and shells; to the southward, fine sand; and on the bank itself, broken shells.

ANGRA DE CINTRA, or Cintra Bay.—At the distance of 3 leagues from the southern extremity of the *Fisherman's Cliffs*, or the Cliffs of the Rio Ouro, amongst a number of oven downs, there is one somewhat elevated above the rest, extending parallel to the coast. From being flattened at its summit, and having its southern extremity peaked, it becomes remarkable. It is situated at a short distance from the beach, at the head of a small bay, named *Angra de Cintra*. This bay is sheltered, on the North, by a very low sandy point, which, detaching itself from the coast, runs parallel to it, and a reef projects from its southern extremity, which may be considered as a continuation of it. The break in the coast, between the northern and southern reefs, which form the opening of this bay, may be about 6 miles; but, on doubling the northern reef, the bay is found to extend about 4 miles inside of the sandy point which protects it.

The depth of water in this bay is not great; at the distance of a mile inside it is only 4½ fathoms, sandy bottom; but the stillness which prevails in it attracts a great number of fish, and it forms a harbour for the night to the fishing vessels of this coast. It is to be observed, that besides the reefs stretching from the North and South points of the bay, there is also a rock near the middle of the entrance, which breaks in blowing weather.

All the coast from the *Bay of Cintra* to the *Rio Ouro* is well stocked with fish, and is frequented by eighteen or twenty small vessels from the Canary Islands, which catch and salt fish for the consumption of those islands. Fresh water may be obtained by digging at the foot of the high down, or sand-hill, above mentioned, as a place of observation.

It does not appear safe to attempt the channel into Cintra Bay, between the point and the northern reef, as the breakers seem to be connected between them; but the entrance to the southward of this danger is quite safe. The least depth found was 6 fathoms, in the middle of the entrance. During the time of the rollers, as the sea breaks over this in 6 fathoms, vessels should pass either to the northward or southward, where they will find from 9 to 10 fathoms. The fishermen who frequent this creek attract some few Arabs, or Moors, to the spot, who seem to have no fixed habitation there, nor on any other part of the coast. These belong to the fourth tribe, who are dispersed in the desert, and called the "Tribe of Thieves," complete wanderers and vagabonds. It is composed of the discontented of the three tribes, which are scattered along the coast from Cape Boiador to the Senegal; they subsist exclusively on dried fish, and the plunder from wrecks, *which formerly were so frequent here*. No advantage can be derived from any communication with these poor and miserable people.

In the Bay of Cintra, at 2 miles from the beach, are from 9 to 16 fathoms of water; the bottom of sand, sand and gravel, sand and shells, sand and mud, generally covering siliceous or flinty rock, of the same nature as the neighbouring coast. Toward the bottom of the bay the mud becomes

thicker; and here the anchor would sink down into a bed of greenish clay, which is excellent holding ground.

Anchorage may be found along the coast from Cintra Bay to the Rio Ouro; but the bottom, from being composed of siliceous rocks, must be unfavourable for holding.

From Cintra Bay the coast trends S.S.W. $\frac{3}{4}$ W. to a distance of 7 leagues; the shore is low, but it gradually rises, and becomes a continued down of white sand. At 3 leagues to the southward of this bay, in the interior, may be seen four or five small insulated sandy downs, which are rather higher than the adjacent ground, and, with the lower one, may serve as a mark for this coast. These heights are called the *Downs of Cintra*, and they can be seen at the distance of 4 or 5 leagues only. The Down of Cintra, a remarkable peaked sand-hill, according to M. Roussin, is in 23° 5′ 25″ N., and 16° 10′ W.

ST. CYPRIAN BAY.—Having run 6½ leagues along a moderately high coast, which presents alternately cliffs and sandy beaches, we arrive at an inlet, or bay, formed by rather a deep bend of the beach. The bottom of this bay is low, and the sea breaks violently on it. The eastern point of the bay is formed by a cliff, 150 ft. high, having a circular form toward the sea, with a flat top, and much resembling a fortification. The western side is also formed by a steep cliff, which, after extending 2½ miles to the westward, turns abruptly to the S.W., and forms Cape Barbas, in 22° 19½′ N., and 16° 39′ W. The bay formed by the cape is that which bears the name of *St. Cyprian*.

The Bay of St. Cyprian, being open from *N.E.* to *W.N.W.* (*true*), is unsheltered from the prevailing wind on the coast. In consequence of this there is generally a heavy sea in it; and the anchorage, although on a bottom of sand and mud, in 10 to 20 fathoms, offers very little security, and should be resorted to only in cases of necessity. The abundance of fish in this bay frequently attracts the fishermen from the Canaries, who, seduced by the hope of being quickly laden, and the appearance of a moderate breeze, anchor too near the bottom of it. In this situation, if the wind freshens up, being equally incapable of beating out with their crazy vessels, or with their ground-tackle of riding out the heavy sea which sets in, they are sure to drive and be thrown up on the beach, where their crews frequently lose their property and lives; or, which is not less deplorable, are robbed and detained in slavery by the Arabs.

From Cape Barbas the coast trends nearly W.S.W. (*S.W.*) 3 leagues. It is formed almost by one uninterrupted cliff, about 80 ft. high, at the foot of which the sea breaks violently. At 1 mile from the beach there are from 9 to 12 fathoms, and at 2 miles, as much as 17 fathoms; with a bottom of muddy sand, or sand and broken shells. The coast then declines into white sandy downs, studded here and there with cliffs. At about 3 leagues from this it forms a rather remarkable little bay, with a shore of white sand. The mouth of this bay is barred, at about 3 miles from its bottom, by a flat of banks and reefs, on which there is very little water. These reefs serve as a foundation for an islet, called that of *Pedra da Gall*, and another small islet, which M. Roussin has named *Virginia*. These islets are merely rocks,

of a nature similar to that of the coast. The first, which is rather higher on the northern than on the southern side, is about half a mile in circumference. The latter, or southern one, is three times that size, and has some sandy patches. It is also 3,000 fathoms from the coast, and about a league *S. by W.* (*true*) of Pedra da Gall. They are connected together by a chain of flats, which stretches 400 fathoms to the S.W., and 1,000 fathoms to the N.E. of Pedra da Gall. At 1 mile westward from these islets may be found 18 fathoms of water, with muddy sand. The depth increases to the southward, and the bottom becomes harder.

From Pedra da Gall to Cape Blanco the distance is 29½ leagues. The coast in this extent is nearly straight, and moderately high; its true direction *S.* 15° *W.*, and it presents only a few indentations of a trifling depth. It is one continued down, the whiteness of which becomes more vivid on approaching to the southward. In some places it presents peaked cliffs, in others there is a gentle descent toward the sea, and the whole is devoid of vegetation.

CAPE CORVOEIRO.—Having, says M. Roussin, on our way from the northward, reached the parallel of 21° 50′ N., after passing a sandy beach of about 2 leagues in extent, with few indentations, we find ourselves abreast of a moderately high cliff, whose irregular summit forms a striking contrast with the uniform smoothness of the adjoining coast. The cliff is 5 miles in length N.E. and S.W., after which the downs again commence, having previously formed a small bay to the southward of the cliff. The most salient point of the cliff is *Cape Corvoeiro*; but it is not well defined, and is only remarkable from the breaks in the beach where it is situated. The strength of the current here is the same as on the whole coast, about nine-tenths of a mile per hour; but further out to sea it loses half that velocity. Between the islets and the coast, at a distance of half a mile from the latter, the depth is from 6 to 9 fathoms, with a bottom of sand, sand and shells, or sand and rocks. At the distance of a mile from the coast it varies from 10 to 20 fathoms, with mud and sand. The muddy bottom prevails to the southward of Cape Corvoeiro, and all this coast is perfectly safe. At 25 leagues to the northward of Cape Blanco we discovered, from the masthead, that the beach along which we were running, was formed by a tongue of sand from 2 to 3 miles in breadth, beyond which we observed water. This is now called *Levrier Bay*, and is situated to the eastward of Cape Blanco. From Cape Corvoeiro the coast is formed of white and red sandy downs, assuming various shapes, alternately terminating at the water's edge in broken cliffs and low sandy beaches.

CAPE BLANCO, in 20° 47′ N., and 17° 4½′ W., is the southernmost face of a white cliff, about 150 ft. high, It rises vertically from a gentle slope which extends from its base to the sea. With a point 4 miles to the northward, it forms a bay, at the bottom of which is a beach of white sand, interspersed with masses of the cliffs. Through one of these masses the sea has perforated a hole, which, in shape, much resembles an arch. The anchorage in the bay, as well as on the whole coast from Cape Corvoeiro, is good; a bottom of muddy sand prevails throughout, with a depth varying from 19 to 12 fathoms. At 1 mile to the southward there are 9 and 12 fathoms, and

large vessels may anchor at this distance to the eastward, where they will be sheltered from the prevailing N.N.E. and N.W. winds.

The portion of coast terminated by Cape Blanco is a long promontory, which, projecting from the main, forms with it a bay of nearly 8 leagues from North to South, and about 6 broad. The bottom in this bay is generally composed of soft mud, and there is a depth of water varying from 40 to 17 ft., reduced to the lowest springs. On the western side there is excellent anchorage for vessels of moderate size.

In a radius of 8 or 10 miles round Cape Blanco, and in Levrier Bay, the currents are subjected to regular tides. The flood sets E.N.E., and the ebb W.S.W., the greatest velocity of either being from 1 to 2 miles per hour; but it attains this rate only when the wind blows with it. The greatest rise above the level of the lowest tide is 10 ft., and it is high water, on the second day after full and change, at $0^h\ 14^m$.*

All this coast abounds with good fish, as cod, bream, soles, &c. On the little beach eastward of Cape Blanco, a single haul of the seine has produced a thousand pounds' weight. The best kind of turtle, namely, the green kind, also abounds hereabout. According to the information obtained from the Canarian fishermen, who frequent the coast, a small quantity of drinkable water may be obtained by digging a little to the northward of Cape Blanco. This spot is occasionally visited by some Arabs, who possess a few muskets, and against whom it is necessary to guard.

In 1830, Captain (Sir Edward) Belcher, in H.M.S. *Ætna*, by the mean of several observations, assigned to the extremity of Cape Blanco, lat. 20° 46′ 26″ N., long. 17° 4′ 10″ W. This gentleman has given a geological description of the cape and neighbouring country, which is inserted in the "Journal of the Royal Geographical Society" (vol. ii., pp. 299—303), and in which he particularly notices the practice of the Canarian fishers, in the vicinity of Greyhound Bay; the anchorage of these vessels, schooners, with their boats, is in a bay about 3 miles North from the cape, where they are quite sheltered from N.N.W. to S.S.E. Those of the fishermen whom Captain (Sir Edward) Belcher met with, were courteous and communicative, and they stated that their usual fishing-ground is in 25 fathoms, where they take fish of from 8 to 60 pounds each, and that their average daily work is about 3 cwt. in the boats. The schooners have polacca foremasts; and, when fishing, they furl all the sails in one; their burden is from 100 to 150 tons. The fish taken by the *Ætna* were porgy, mullet of several kinds, rock-cod, and red-snappers, probably called bream by former voyagers. Mussels and other shell-fish are very abundant at low water.

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* "The tides about Cape Blanco are irregular, and much influenced by the land near which they run. High water, at full and change, may be looked for about noon; the greatest rise, under every advantage of springs and winds, does not exceed 6 feet. Southward of the parallel of the cape the indraught has a velocity of 2·6 miles, and the off-set or ebb the same. Eastward of the meridian of the cape the tide bends northerly, and at 3 miles chord its velocity appears from S.W. to N.E., about $1\frac{1}{2}$, following the circular course into Levrier or Greyhound Bay. North of the parallel of the cape the ebb sets North, and flood South; and, close in-shore, the tide is considerably weaker than at 3 miles, where its greatest influence may be expected."—*Captain Sir Edw. Belcher.*

The summit of the Blanco Peninsula is composed of lines of sand hills and rocky eminences, just what one would expect to find if the sea were to quit its position, and show us the beds over which it flows. In every position, where a bush or rocky islet is prominent, there, on its southern side, you will surely find its sand hill—a proof of the prevalent winds, as well as an admirable model of the formation of shoals, &c., under water, and pointing out most perfectly the "steep-to" approaches to banks, past which rapid streams or currents flow, with their concomitant shallow tail, formed by dead water or eddies.

With the exception of these new-formed and forming sand-hills, the whole surface is covered, in a *most extraordinary manner*, with shells, of all dimensions, and of the species generally found in the bay. These are loose, and some are more than 60 ft. above the level of the sea.*

The Spaniards affirm that there is no rainy season here, but strong northerly and north-easterly winds the whole year. In June and July they were North, N.N.E., and N.E. Highest temperature of air in the shade, 75°; of the water, 76°.

BANK OF ARGUIN, &c.—The Bank of Arguin commences at 4 leagues to the southward of Cape Blanco. It is a great shelf of about 30 leagues in length, and reaches to the southward of Cape Mirik. The North point of it is in lat. 20° 33′ 12″ N., long. 10° 56′ 30″ W. The coast between this point and Cape Blanco is replete with shoals. The most considerable one is that of the *Bayadére*, at 1 5-10th miles to the southward of the cape. There are only 20 ft. of water on this shoal, and it occasionally breaks. Another lies W. ¾ N. (*W. by S.*) 3 miles from the cape; and a third at 8 miles S.S.E. ¼ E. (*S.E.*) of it; on which, like the first, 20 ft. of water have been found. The channel, leading to the anchorage, eastward of Cape Blanco, lies to the northward of these shoals.

The *Bank of Arguin* is a flat of sand, constantly increasing, of the same nature as the coast. The body of it is hard, and covered with broken shells. Its outer edge, which has been traced from numerous soundings, has been fixed at the depth of 8 fathoms, as no vessel can run within this limit without risk; and, at a very short distance to the eastward of this boundary, there is less than 4 fathoms. No particular part on the edge of this bank has been seen quite dry; but close to the breakers, which occur in many places, there are not more than 10 ft. of water; and the shallows between them do not appear to have more.

Between the North point of the bank and its western extremity, situated in 20° 6′ 20″ N., and 17° 7′ 30″ W., on advancing from seaward, the soundings progressively decrease. At 10 leagues to the westward, from 40

* The *Island of Arguin* lies in the mouth of a bay to the S.E. of Cape Blanco. According to Captain Grover's account it is about 8 miles from the main land, between which and the island the water is shallow. To the seaward there is a depth of from 5 to 7 fathoms *close to the shore*. On this point the evidence appears to be conclusive. It is formed of a whitish rock, covered with shifting sands to the depth of 9 feet. The South end rises to about 30 feet. The island produces no wood, and only a small caustic shrub, but has excellent water, though of milky appearance. The wells are difficult to find, but are important. The number of inhabitants was about 60.

fathoms they decrease to 8, with a very gentle ascent; but to the southward of this parallel the bottom becomes more uneven; and from the point where the *Medusa* was lost, in 1816, in lat. 19° 53′ 42″, long. 17° 0′ 35″, a great irregularity takes place.

From the westernmost extremity, the edge of the bank trends S.S.E. (*S.E.* ¼ *S.*), and extends as far as Cape Mirik. The nature of the ground about the Bank of Arguin has a very remarkable characteristic, which may prove of great service to navigators. From the depth of 8 fathoms, which has been assigned as the limits of this bank, to that of 25, to seaward, including an extent of more than 5 leagues, the lead invariably brings up a mixture of sand and broken shells; and, in proportion to the proximity of the bank, the latter prevail. Beyond the depth of 25 fathoms, as far as that of 55 and 50, at 8 or 10 leagues to seaward, the bottom is entirely of white sand. Hence it is evident, that by soundings, and a rough observation for latitude, the distance from the Bank of Arguin may always be known. Should less than 25 fathoms be found, with a bottom of sand and broken shells, you will be less than 5 leagues from its edge; and in proportion as shells predominate in the soundings, you will be nearer to it, and should avoid getting to the eastward. Should you have more than 25 fathoms, with fine sand, you will be more than 5 leagues from it. To the northward of the parallel of 20° N., this may be particularly depended on; to the southward of that limit, it is subject to some exceptions; but as the bank then takes a direction S.S.E. (*S.E.* ¼ *S.*), it becomes no longer dangerous, if a ship is kept on a wind in 20 to 25 fathoms, and sounds frequently. Henceforth we may conclude (which all mariners must be convinced of), that a strict attention to incessant sounding is so indispensable as to need no further recommendation.

Currents.—It has been already shown, in pages 328 and 338, that the prevailing currents set from North to South along the whole coast. Along the edge of the Bank of Arguin, as far as its western extremity, this direction is constant; and in the rainy season, should any deviation be experienced, it may be relied on to happen very seldom. One proof of this may be adduced. On the 13th of July, when the wreck of the *Medusa* was found by the brig *Argus*, after 13 days' absence from the frigate, it was abreast of Portandik, at 15 leagues from the shore, a distance of 90 miles, and nearly on the meridian of the place where she was lost. It must, therefore, have driven at the rate of 7 miles per day along the coast.

Cape Mirik is that point of the coast which terminates the Bay of Arguin on the South, being a very low sandy point, on which there is a small down.* It is surrounded by the southern part of the Bank of Arguin, and cannot be approached by large vessels, on the West, within 3 leagues, and on the S.W. within two.

Tanit Bay.—The coast from Cape Mirik tends S.S.E. ¼ E. (*S.E.*) 10 leagues, it then forms a complete elbow, gradually trending S. ¾ W.

* Captain Owen gives this down in 19° 25′ N., and 16° 34′ W. Baron Roussin as 19° 22′ 11″ N., and 16° 31′ 21″ W.

(*S. by E.*) It is low, and presents a continued chain of small regular downs, composed of white sand, and interspersed with small bushes. To the northward of the bay, formed by the bend of the coast, some downs may be observed which are rather higher and more insulated than the rest. A few huts are seen near the beach, and in the dry season numerous parties of the thieving tribe assemble here to catch fish and dry their stock. Two large pieces of water may be seen between the high downs; but whether these be fresh or salt is unknown. The latter seems most probable. The bay bears the name of *Tanit*, and the North point of the down, at the bottom of it, as observed by Baron Roussin, is in 19° 3′ 48″ N., and 16° 12′ 20″ W.

Angel Hillocks.—From *Tanit Bay* the general direction of the coast is South in an extent of 12 leagues. At the distance of 4 leagues from the termination of this bearing are some downs, which are rather higher than the rest of the beach, and with some bushes on their surface. The beach itself is formed by a very low flat of quick-sand. These downs are the Angel Hillocks, composed of sand, of which the summit is from 15 to 20 fathoms above the sea, and they constitute a useful land-mark. They are divided into two groups; the summit of the northernmost, which is much smaller than the other, is studded with tufts of brushwood, while the southern, which is formed of eight or nine hummocks, is nearly destitute of it. The latter, which is the highest, stands in 18° 29′ 30″ N., and 16° 2′ W. The coast, from these hillocks, gradually declines in height, and more so as it approaches to the southward, when it soon falls into a uniform line of sand, with occasionally a bush here and there, scarcely above the level of the sea.

Angel Bank.—No part of this coast, southward from Cape Mirik, should be approached within 5 miles, nor to a less depth than 6½ fathoms. By attending to this rule all dangers will be avoided, and, amongst others, a shoal which extends outward, 3 miles from the coasts, abreast of the northern part of the Angel Hillocks, from which it derives its name. On this bank there are regular soundings on a bottom of sand, with sand and broken shells, affording anchorage in case of necessity. On receding from the beach the depth increases; and, at some distance from it, is greater than to the northward of the hillocks.

PORTANDIC.*—At 4 leagues to the southward of the Angel Hillocks, on rather an elevated part of the coast, and a little within the beach, there is a stunted palm, and the only one seen on the coast between this and Cape Boiador. It is in lat. 18° 18′ 54″ N., long. 16° 2′ 12″ W, and Portandic is supposed to have existed at about 1 mile to the southward of this spot. Not a vestige now remains sufficient even to indicate to strangers the spot on which this little establishment once stood. But since the survey it has been ceded to France, and a fort is mentioned. From the palm tree the coast trends nearly S.S.W. (*South*), then S.W. (*S. S. W.*) It is straight and

* By a convention, signed March 7th, 1857, the Queen of England relinquished her rights to trade between the mouth of the River St. John and the Bay and Port of Portandic inclusively, and in return the French ceded the Factory, or Comptoir, of Albreda, on the North Bank of the Gambia, with all rights belonging thereto.

low, interspersed with small bushes, and presents a continued sameness. In an extent of 35 leagues there are only two downs of red sand, covered with brushwood, and discernible only at about 2 miles from the beach. One is in lat. 17° 25′ N., the other in 16° 55′ N. From the mast-head some sheets of water at the foot of these downs may be seen. At 2 leagues to the southward of the latter the interior of the country becomes a little clothed with brushwood, and occasionally presents some level plains, but the coast remains uniformly barren.

Portandic to the River Senegal.—On the parallel of 16° 35′ 24″, and at the termination of the 35 leagues of coast already described, we arrive at the huts of *Inguiagher*, or the spot called by the French the *Marigot* or Lagoon of *Mosquitos*. This in the rainy season forms a mouth of the River Senegal, the banks of which are covered with mangroves. At the distance of 2 or 3 miles from the beach regular soundings may be found, in from 7 to 13 fathoms, fine sand, occasionally mixed with mud, affording safe anchorage between this and the palm of Portandic. To the southward the depth gradually increases.

The Marigot of Mosquitos is about 12 leagues to the northward of the Isle of St. Louis, in the Senegal; and it communicates with the sea only when the rains have swollen the river. It then covers the bank at its entrance, which may be passed over by boats; but they must be prepared against the surf which is common to it, as well as the entrance of the Senegal. To the southward of this *Marigot* the river is separated from the ocean by a straight tongue of sand, formed by small white downs, nearly bare, and gradually becoming lower toward the extremity. Within this tongue of sand the stream of the Senegal washes a number of small islands which lie parallel to the coast, and on which a covering of thick bushes gives the country some appearance of fertility. They are known by the name of the *Antelope Islands*, *Griel Wood Island*, and *Thiong Islands*. This last is at a very short distance to the northward of the Isle of St. Louis.

Griel Wood Island is distinguished by its bushes, among which are some trees higher than the rest, presenting a remarkable contrast to the barren desert of 200 leagues, which precedes it. Its distance from the Isle of St. Louis, in a straight line, is not more than 5½ leagues. Both to the northward and southward of Griel Wood Isle, the stream of the river may be distinctly seen from the mast-head, running between the isle and the beach; and it is the surest mark for discovering the landing-place to the northward of the bar.

A vessel may run along the coast, at the distance of 2 miles from the beach, in from 9 to 14 fathoms, over an excellent bottom of thick green mud.

SENEGAL.—On continuing your route to the southward, the French establishment of St. Louis, in the Senegal, will soon be seen. This place is remarkable for its white buildings, and a very high palm-tree, which stands conspicuously close before the flag of the fort. The latter is in lat. 16° 0′ 48″ N., and long. 16° 31′ 1″ W. The western bank of the Senegal is so narrow and low, abreast of the northern part of this island, that the town appears to stand on the sea-shore; and it is only on nearing it that the channel which separates them can be seen.

On passing near the Isle of Senegal it affords a very agreeable prospect.

Fort St. Louis forms the principal object in this perspective. To its right and left extend the two parts of the town, the streets of which are well arranged. The woods which line the East bank of the river appear, at a distance, to belong to the isle, and give it a cheerful and rural aspect; but this illusion disappears on a nearer approach; for no place can be more arid, parched, or deprived of vegetation, than the Isle of St. Louis, the soil of which is nothing but a fine shifting sand. The water of the isle is brackish and unwholesome.

Mr. Hutchinson, in a paper read before the Society of Arts, in March, 1874, remarks respecting the trade here:—"Of the trade at Senegal there is not much to be told. The chief articles of export from this are gum Arabic, ground nuts (the *Arachis hypogea*), and hides; gold-dust and ivory are sometimes exported, but in small quantities. Its chief importance arises from the fact of the river here being the inlet to the principal French colony on the coast. The capital, St. Louis, situated about 20 miles up the stream, is garrisoned with a large force. Of these, however, there is but a small amount who are native Frenchmen, the majority being Negroes and Mulattoes. By the treaty of our government with France, relative to West African affairs, in 1783, it was stipulated that the English gum trade should be confined to Portandik, which is about 100 miles North of the Senegal *embouchure*."

A light is shown on the government house on the Ile de St. Louis, and it is proposed to establish a light on the North end of the isle.

A little Moorish town, *Gattandar*, consisting of huts on a sand hill, stands upon the strand, opposite the town of St. Louis. From this place a canoe is launched on the approach of a vessel. The anchorage off the mouth of the river may be taken in 7 to 1 fathoms, according to circumstances. The depth extends from 2 to 4 miles to the bar.

If standing in for the land by night, heave a cast of the lead every hour, as you fall into soundings all at once, 50 fathoms close to the edge of the bank, at the distance shown on the chart, or about 8 leagues from shore, and thence shoaling to 8 fathoms at $1\frac{1}{2}$ mile from it.

The mouth of the Senegal presents nothing remarkable when seen from the northward. The breakers which prevail on the whole coast as far as *Point Barbary*, the northern point of the entrance, prevent those on the bar from being distinguished; and vessels may run past without seeing them, if they keep at too great a distance from the shore. From Gattandar you may run at the distance of a mile from the beach without danger; which will enable you to observe the smallest alteration in the coast. A small post in the centre of the river, abreast of the *English Islet*, where there is a signal-post, and a guard-house on *Babague Island*, at a short distance to the eastward of the bar, will then be passed in succession. This guard-house is a remarkable small square house, near which there is a second signal-staff; and a vessel may anchor when this guard-house bears E. $\frac{3}{4}$ S. (*E. by N.*) As the winds generally blow from the northward, in consequence of the facility for communicaion with the shore, it is advisable to anchor rather to the northward than to the southward of the bar.

The Bar of the Senegal is not stationary, and is generally available for vessels drawing 11 ft. water. The western bank of the river, from the Isle of St.

Louis, is so low that high tides completely cover it, and, at times, force open a new channel. Its northern point, in 1817, was in lat. 15° 55′ 18″ N., and long. 16° 30′ W., and it increases gradually to the southward. As the nature of the entrance is so variable, it is manifest that no safe directions can be given. In April, 1873, "the entrance of the river was divided into two parts by two shoals, situated nearly in the middle. These banks form two passes: one along the Barberie land, and the other along the Cayor shore. The North channel only is practicable for ships. It extends in a S.W. and N.E. direction for 1,968 yards; the width being about 87 yards, and the depth varying from 8 to 11 feet. With the flood tide the current runs at the rate of 2 knots, while with the ebb its strength is about 4 knots, with a direction extremely variable. From the middle of this channel the Marché de Grandiolle bears S. 15° E.; Pilot Station N. 36° E. The South Channel seems to be improving, having now a depth at the entrance of from 12 to 15 feet. It runs first East, drawing close to the Grandiolle shore, then turning abruptly to the North, along the mainland, it joins the stream, passing over a small bank with only 3 feet water over it."

The dangers attending the bar of the Senegal are well known to be of no trifling nature. In the rainy season, and even in March, when the river, increased by the rains, discharges a greater body of water into the sea, the bar is frequently impracticable even by decked boats. The waves, caused by the impetuosity of the river water meeting with that of the ocean, are very considerable, and succeed each other so rapidly that it is impossible to find a *smooth*. It is not uncommon, in these cases, to see breakers at the distance of a mile from the bar, and in 8 fathoms of water. From the month of April to the end of September the bar may generally be crossed by decked boats, and sometimes even by canoes; but it is advisable that they should be steered by natives.

At times the waves are very remarkable. When the sea is but slightly agitated, one may perceive three waves, perfectly distinct, approach and break against the bar, immediately after each other; and these three waves appear to be, as it were, connected; for there is often a considerable interval of time between the attack of the first three waves and the approach of the succeeding trio.

Vessels of a moderate size only should be employed in the commeracil navigation of these parts; otherwise the loading and unloading, when necessary to employ lighters, becomes expensive. Inside the mouth the depth is from 6 to 8 fathoms: and, with the assistance of the tide and a pilot, a vessel may very easily beat up to the Isle of St. Louis.

Winds.—The winds are not at all dangerous in the navigation of the coasts of the Senegal. They blow nearly along the coast from the N.E. and N.W. during the greater part of the year; and as, in the rainy season, the squalls always come from the S.E., and the winds which succeed them are very weak, when they once pass the S.W. quarter, getting under way is always easy. Those vessels in the road which cannot depend on their ground tackle, may return to it when the squall is over.

Currents.—It has already been said that the general and almost constant direction of the current is along the coast from North to South, as far as the

mouth of the Senegal. Abreast of this opening, and in a space of several miles to seaward, the river tides affect the general uniformity of this current. The flood and ebb tides are alternately felt at the bar and anchorage; they have no settled direction, but may be considered as setting about N.W. and S.E.; and are frequently so strong as to make the vessels tend at the anchorage, or at least to lay with their broadsides to the wind, in the strongest breezes. This anchorage is rendered very inconvenient by the short sea which is always upon it.

Senegal to Cape Verde.—If a straight line were drawn from the anchorage at the bar of the Senegal to the *red light* on Almadie Point lying N.W. ½ W. 2 miles from Cape Verde Light, its direction would be nearly S.W. by W. ¼ W. [*S.* 40° *W.*], and its length 31 leagues. The arc described by the intervening coast, and subtended by this chord, bends so little, that it would not exceed the whole length by more than 4 leagues, and its greatest depth would be 13 miles.

The coast, as far as 2 or 3 leagues to the southward of the Senegal, is just as low as that to the northward, and resembles it very much; it afterward becomes rather higher, but is uniform in general appearance. It is composed of a chain of white sandy downs, scattered over with brushwood, amongst which a small cluster of trees may be distinguished. It generally presents two well defined plans. The first is the next to the sea, formed of white sandy downs, on which there appears some verdure. The second, which is considerably higher than the first, commences at about 2 miles in the interior, and is formed by downs of a greyish colour, which are covered with bushes.

In running for the Senegal, from the southward, the mouth of the river is more easily distinguished than when approaching from the northward, from its appearing more open. At the distance of 8 leagues from the mouth, and on the parallel of 15° 26′ N., a large red sandy down may be observed, entirely bare, which, to those ignorant of their latitude, may serve to indicate their distance to the southward of the bar. From this down, southward, the coast presents nothing remarkable as far as the *Little Paps*, of which the northern is in latitude 14° 56′ 24″ N., and longitude 17° 4′ 30″ W. The *Little Paps* are the two highest downs between the Senegal and the *Paps of Cape Verde*. They are situated on the beach, and are easily known by a slight undulation of their summit, and three or four other small hills adjoining them to the southward. They are visible at the distance of 4 or 5 leagues. The *Bay of Yof* commences from this point.

The Little Paps bear E.N.E. ½ E. [*N.* 50° *E.*] from those on Cape Verde, at the distance of 9 leagues. When running this distance, in fine, clear weather, both are frequently seen at once. The latter may be seen at the distances of 7 or 8 leagues. From about 8 leagues to the eastward of Cape Verde, the coast rises very much, and becomes more wooded. The country about the cape is covered with trees, amongst which there are several of remarkable height. All this coast may be approached within a very short distance. Within 2 miles to the northward of the village of Yof, situated near an islet of that name, there are 55 fathoms of water on a bottom of mud and sand.

CAPE VERDE is the westernmost point of Africa; it is the extremity of

a peninsula formed on the North by the Bay of Yof, and on the South by the bay in which the Isles of Goree and Dakar are situated, and is composed of moderately high land. To the westward, as far as the two paps, the coast next the sea becomes nearly perpendicular. Cape Verde, as seen from the northward, terminates in very low land, on which are some unconnected hillocks, which, at a distance, may be taken for islets.

The Lighthouse stands on the western mound of Cape Verde. It is 65 ft. high, and shows a powerful *revolving light* every half minute, at an elevation of 370 ft. above the sea, and visible 27 miles off. The lighthouse, which is white, with a bronze lantern, is 65 ft. high, and situated in lat. 14° 43′ 30″ N., long. 17° 31′ W.

The extreme point of Cape Verde extends 1,000 fathoms still further West, in a flat of blackish rocks, awash with the water's edge, and which, in two or three places, rise from 8 to 10 ft. above the level of the sea. This rocky flat is called the *Almadies*, and the point which joins it, *Almadie Point*, on which a *fixed red light* is shown from a square white tower, 39 feet high. From it the lighthouse on Cape Verde bears S.E. ¼ E. 2 miles, and the extremity of the point westward is distant 1 mile.

The sea on the Almadies breaks incessantly. Amongst the rocks are some smooth spots appearing like channels fit for boats. The flat may be coasted at the distance of a mile, there being, on the West, 35 fathoms of water; the bottom is of broken shells. Hence to the northward, in an extent of 3 miles, the depth increases to 80 fathoms, bottom of mud and sand. To the S.E. the depth is not so much; in running along these breakers and the coast, to a distance of 2 miles in that direction, which will extend to the meridian of the paps, the depth varies from 25 to 39 fathoms, the bottom, sand and shells, or sand and rock. The depth then continues to decrease to the E.S.E. The highest and westernmost rock of the Almadies, which appears from a distance in the shape of a die, is in lat. 14° 44′ 29″, and long. 17° 33′ 29″, as shown in the Table, p. 32.

The prevailing currents between the Senegal and Cape Verde follow the direction of the coast, in the same manner as those to the northward; and the idea of a current setting violently into the Bay of Yof is altogether false. The sea on this part of the coast is not particularly heavy nor dangerous; the smallest coasters of the Senegal and Goree expose themselves to it with impunity every day.

Southward from the Senegal, as far as parallel of 15° 20′, including an extent of more than 12 leagues, at 2 or 3 miles from the coast, the bottom is excellent, being of pure mud, with a depth varying from 12 to 30 fathoms. From this parallel, to the southward, doubtless the depth increases considerably. At 2 leagues to the westward of the Little Paps, for instance, there are from 64 to 70 fathoms of water. The muddy bottom continues here, and is so soft that the lead sinks deep into it, and the anchor alone would hold any vessel obliged to come to in consequence of calm. It is only in these cases that anchoring becomes necessary; if there is wind from either quarter, the formation of the coast will always allow a favourable board to any vessel well found and well managed.

From Almadie Point to Cape Manuel the coast trends S.S.E. ¼ E. [*S.E.*] in a distance of about 3 leagues. In this extent it is high, covered with

trees, and generally terminates at the sea-side in basaltic cliffs or sandy rocks. In some places only the cliff slopes towards the interior, and forms small bays with beaches of white sand.

At 2,000 fathoms N.W. by W. ¼ W. [*W. by N.*] off Cape Manuel, and at half that distance from the coast, there is a group of rocky islets, called the *Magdalen Isles*, of which there are two principal ones. They are perfectly barren; even the largest, in the crevices of which were formerly some *baobabs*,* is nothing but a bare rock of a reddish colour mixed with basalt, and perfectly destitute of any vegetation. The shape of this islet is that of a crescent open to the westward, and its greatest extent is nearly North and South. On the North side it has a gap, forming a very small creek, which affords a landing. The other rocks are to the south-eastward of the principal islet, separated by a space of 1,000 fathoms, in which there is a depth of from 4 to 6 fathoms. The sea breaks with violence on all these rocks.

The space between the Magdalen Islands and the main seems to offer a safe channel; but it should not be attempted by a stranger. In coasting the shore from the Almadies to the Magdalen Islands, the soundings vary from 34 to 19 fathoms. These islands may be approached on the southern side within 100 fathoms.

Cape Manuel is high, formed of columns of basalt, and covered with very thick brushwood. *The lighthouse* is a square tower built on the cliff, 39 feet high, and bears S.S.E. from Cape Verde light 6 miles distant. It shows a *fixed red light*, visible 8 miles off. At the distance of a pistol-shot from it, to the southward, there is a depth of 8 fathoms; and at 100 fathoms to the north-westward of its extreme point, close to the beach, is a small insulated rock. In doubling Cape Manuel, the extensive bay is opened, which is formed by this cape and Cape Naze, which may be called the *Bay of Goree*. At the distance of 2,100 fathoms from Cape Manuel, E. ½ N. [*N.* 65° E.] lies the Island *Goree;* and a vessel intending to anchor must steer for it, and may approach on the South side within two musket shots.

GOREE.—The Island of Goree with the Senegal fell into the hands of the British in 1809. By the treaty of Paris they were restored to the French in 1816. As far as regards climate, they are more favourably situated than any of our settlements on the coast. The adjoining country is inhabited by the Jaloff nation. Gum, copal, and ground nuts are the principal exports, chiefly to Rouen and Marseilles. The French Government attach much importance to its maintenance, and have expended large sums on its military defences, and in the construction of the port of Dakar.

Goree Isle is merely a rock; about 400 fathoms in its greatest length, from N. by E. ¼ E. to S. by W. ¼ W. (*N. by W. to S. by E.*), and 167 fathoms in breadth. It is a volcanic production, composed of basalt and sand, of the same description as the Magdalen Islands and Cape Manuel, from which it seems to have been separated. The southern part, which is about 500 feet above the level of the sea, is the highest, and like a round mountain, may

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* The *baobab* (or *Adansonia*) is a species of a very large tree, of a fine green colour, but which does not keep its verdure all the year round. From the trees of this sort on Cape Verde that cape derived its name.

be seen at the distance of 5 or 6 leagues. The rest of the island is very low, and the North point is distinguished only by its batteries and private buildings. A *fixed light* is shown from the fort. The landing-place is on the N.E. side of the island, between the point and the back of the mountain; to the southward, is a small sandy bay.

The roadstead is to the N.E. of the island. This roadstead, which is sheltered from all winds from S.S.W. to N.N.E. (by the North), is perfectly safe during eight months of the year; that is, from the 1st of November to the 1st of July; but during the rainy season, the squalls from the S.E. are dangerous. The best anchorage for large vessels, in either season, is at the distance of 800 fathoms from the landing-place, with Cape Manuel Lighthouse bearing W. by S. ½ S. (*S. 52° W.*), a sail's breadth open of the North point of the island. At this spot there is a bottom of thick clayish mud, with a depth of 12½ fathoms, and it is convenient to weigh from, with the wind from any quarter.

To fetch the anchorage from Cape Verde, in the fine season, when the winds are from N.E. to N.W., it is necessary to run close by Cape Manuel and the South point of Goree, keeping by the wind on the port tack, and sounding until in 8 or 10 fathoms. When within a mile of the land, tack and beat up to the anchorage. All the channel between Goree and the Peninsula of Cape Verde is perfectly safe, having in it from 5 to 13 fathoms of water, and the shores may be approached within the distance of 200 fathoms. A vessel intending to remain any time at the anchorage should moor N.E. and S.W., as the two cables will then bear an equal strain in the heaviest of the squalls.

The watering-place of Goree, used by vessels which frequent this island, is about 3,000 fathoms N.N.W. of the anchorage. It consists of several pits dug in the sand on the sea-side, near a marsh, and close to a negro village called *Han*. The water is neither agreeable nor wholsome, and should not be drunk until it has been filtered, acidulated, or cleansed by boiling or other means. The cove in which it is situate is exceedingly well stocked with fish, and hauling the seine will be attended with success, by any number of vessels touching here.

DAKAR.—This port is established on the coast nearly due West *true* from the Island of Goree, the channel between being 2 miles wide.

Some important works are executed here by the French Government to make a coaling station, and to afford vessels frequenting the colony of Senegal a port of shelter from the dangerous effects of tornadoes, which are common on this coast in the winter. The island of Goree had been considered as suitable, but it was discovered that the ground was not sufficiently firm. Therefore the Bay of Dakar on the main land opposite to Goree was selected.

In the Bay of Dakar two jetties are constructed, forming a double basin. One above 300 yards in length, with depths of 3 and 4 fathoms, and the other, which is 350 yards in extent, is carried out to a depth of 6 fathoms, and affords shelter to vessels of the largest size. A *bright light*, elevated 15 feet, is shown on the head of the East pier.

By the accounts from Senegal (March, 1865), the *Serre*, troop-ship, of 900 tons, and 259 feet long, was in the road of Dakar. This vessel had

anchored between the two jetties, and 230 feet from the second, and had a depth of 5½ fathoms under her bows, and 5 astern, and by the commander's account she was entirely sheltered from the sea and tide.

The coast, from Cape Manuel to Cape Naze, which forms Goree Bay, may be run along at the distance of 2 miles. One bank only lies at 800 fathoms E.S.E. ½ E. (*E.* 3° *N.*) from Cape Belair, having soundings which vary from 16 feet to 12 fathoms, with a bottom of muddy sand, or sand and shells, as far as the parallel of Cape Naze.

From the Bay of Han, northward of Goree, the coast rises a little at some miles in the interior, but it is exceedingly low at the sea-side, where it presents nothing but a white sandy strand. We again perceive the little downs, the chain of which joins the paps of Cape Verde, and which we run along in going round the Bay of Yof. Those downs rise progressively to the south-eastward, and are covered with trees as far as Cape Naze. The Naze Cape is terminated by cliffs of about 200 fathoms in height, the woody summit of which may be seen, in fine weather, at a distance of 7 or 8 leagues. In running along the coast toward Cape Naze, we pass successively several negro villages of the kingdoms of Cayo and Baol, belonging to Damel. The most considerable of these villages is *Rufisk*, on the eastern side of Goree Bay, then follow the anchorages of *Barnier*, *Red Cape*, *Yongop*, &c., all of which points are frequented by coasters from Goree, who trade for stock; they offer nothing interesting. The highest part of Cape Naze is in lat. 14° 31′ 30″ N., and long. 17° 7′ 25″ W.

There are some rocks, westward of Rufish, stretching into the sea, which may be avoided by keeping half a mile from the shore. To the West and W.N.W. of Cape Naze is good anchorage, in 4 or 5 fathoms, fine sand; but to the South and S.W. of the cape the bottom, generally, is not good.

In the night time, you must proceed in 17 fathoms, having sometimes recourse to the lead; the land, even in the night, will direct you sufficiently to avoid the rocks. In the season of the tornadoes the road of Rufisk is not good; but in the summer, you may safely lie there in 6 or 7 fathoms close to the shore, if agreeable.

About 3⅓ miles S.E. of the Red Cape lies Cape Naze, with a small bay between; from the latter the coast extends to the S.S.E. ¾ E. (*S.E.* ½ *E.*) about 4½ leagues, as far as *Portudal*, formerly a French factory; and then 5 leagues S. ¾ E. (*S.S.E.* ½ *E.*) to *Cape Serene;* between this cape and Portudal, 2 leagues off the coast, and parallel to it, lies *Amboroo Bank*, on the South tail of which you find only 1½ fathom. Ships that come from the westward must be cautious of this shoal; the ground is very hard upon it, and close to it is a depth of 5 fathoms.

To the S.E. of Cape Naze the land declines in height, and the downs are partially covered with bushes. The point near a little river, the *Soman*, is thus covered, and the country hereabout appears to be clothed with trees.

Portudal consists of a number of huts on the shore. The coasters of Goree frequent this place. All the coast in the vicinity abounds in trees; and at 2 miles to the southward of the village is a small wood, very remark-

able from its trees being much higher than the rest, and which, therefore, serve as a mark for the coast.*

The Road of Portudal is far from being good, and is fit for small vessels only; they lie close to the shore, athwart of the little houses between the cliffs. All the coast near Portudal is bordered with rocks, and must not be approached too near.

Joal.—Three leagues S.E. ¾ E. (*E.S.E.* ½ *E.*) from Cape Serene lies Joal or Yoal, standing on the North bank of a river of the same name, from which a shoal, with only 2½ fathoms of water upon it, projects into the sea. The Road of Joal is not much better than those we have just mentioned; the entrance of the river, between Joal Point and the point to the South of it, which they called *Palmarin Point*, is 3 miles broad, with a depth of 3 fathoms of water in mid-channel.

Colonel L. S. O'Connor, C.B., Governor of the Gambia, paid a visit to the King of Bur Sin, at his seaport of Joal, in January, 1856. His object was to enter into a treaty for the protection of vessels and persons wrecked on these shores, which was carried out, and therefore some appeal may be made hereafter to that treaty should misfortune render it necessary.

From Palmarin Point to the northernmost of the *Birds' Islands* the coast extends S. ¾ E. (*S.S.E.* ½ *E.*) 8 leagues; and, from the mouth of the Salum River, which lies 4 leagues south-eastward of the point, to the Birds' Islands, the shore is bordered with a sand, named the *Red Bank*, that stretches 4 miles into the sea, and close to which are 4 fathoms of water. The Birds' Islands, four in number, and very small, lie on the bank.

TheSalum River is navigable for 90 miles, and vessels of 250 to 300 tons can always ascend it easily to Khaolah; the last and principal trading port, and to which the tide extends. The bottom throughout is of soft mud, and therefore may be grounded on without danger. All the people at Goree are intimate with the river, and can act as pilots. The only difficulty is the bar, which, like that of the Senegal, is liable to shift, and is extending to the South. The Sandy Point of Sangomar has thus extended a mile since 1828, the period of the survey. The bar is only about 50 yards broad, and on it are from 8 to 9 ft. water, perhaps less at spring tides. In taking the bar you must be able to bear freely to the N.E. by compass, which may be readily done with the sea breeze (N.N.W.) in the afternoon. The best time is therefore the two or three days following the first and last quarter of the moon: it is high water then at from 4 to 6 p.m., and you can make sail for the bar at 2 or 3 o'clock the moment the breeze sets in and is well established, but not if it is too fresh, for then the breakers are strong.

From Palmarin Point to the pitch of *Cape St. Mary* the distance is 11 leagues, S. ¼ W. (*S. by E.* ½ *E.*) The entrance of the Gambia lies between the pitch of that cape and the low islets called the Birds' Isles.

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* A more particular detail of this coast, and of all the shore between Cape Naze and Cape Roxo, by *M. Le Predour* (extracted from the *Annales Maritimes*), was published at Paris in 1828. To the description is annexed a copious table of the positions of places, as determined in 1826 and 1827, on board the frigate *La Flore* and goelette *La Dorade*, under the orders of Captain *Massieu de Cherval*, which may be advantegeously compared with more recent observations.

In sailing off the coast between Cape Verde and the Gambia, shipping must proceed with caution, as the Amboroo Bank, the shoals of Joal, and the banks in the vicinity of the River Salum, are dangerous, being very shoal.

RIVER GAMBIA.—Between the parallels of 13° 30′ and 13° 40′, in an extent of 10 miles, is the estuary or mouth of the great *River Gambia*. It is bounded on the South side by a point named *Cape St. Mary*, on which a fixed light was formerly shown. A *red* light was also shown on Barra Point, but these lights have been discontinued. On a point 6 miles S.E. ¾ E. (*E.S.E.* ½ *E.*) from this is the British settlement and town of *Bathurst*.

The Gambia is one of the principal colonies of the British on the coast of Africa, and the nearest to Europe, a fortnight or three weeks being sufficient time for a steamer to reach the Thames from Bathurst. The advantages of this noble river for carrying on trade with the natives in the interior were well known upwards of 240 years ago, for a company was formed in England for that purpose in 1818. From the time of the first voyager, Thompson, at that period, up to that of Mungo Park, in 1795, it was considered that the Gambia and Senegal were branches of the Niger. Several expeditions were sent out, and the British factory was placed on the small Island of St. James, about 17 miles from St. Mary's. Besides this settlement in 1724, the African Company had another factory at Joar, about 100 miles distant from St. James's Island. In 1688, the latter fort was destroyed by the French.

In 1816 the new settlement, the present Bathurst, was formed at the Island of St. Mary's, on the faith of a treaty for the exclusive trade with the Gambia with the French. The Island of St. Mary's was purchased from the King of Combo; and on the opposite bank, a large tract of country, extending 1 mile inland, and about 36 miles long, was purchased from the King of Barra. It is to the eastward of Barra Point, and is of little advantage except as giving a command of the mouth of the river. There is no British establishment on this tract except Fort Bullen, immediately opposite to Bathurst, and a small house, the residence of a missionary.

In the vicinity of Cape St. Mary's, 7 or 8 miles to the southward of Bathurst, is a more valuable territory acquired by Lieutenant-Governor Huntley, in 1840, by purchase; i, is called Baccow, and has some barracks for the African corps.

M'Carthy's Island is another British settlement, up the river, at the distance of about 175 miles from St. Mary's, though this distance is usually called 300 or 250 miles. The island is about 5½ miles long and 1 mile broad, and the river is navigable up to it for vessels of large tonnage; beyond it the trade is carried on in small schooners; the breadth of the river here is about 200 yards. The falls of Barraconda, which stop the navigation of the Gambia, are about 300 miles above St. Mary's, and from this to Fort St. Joseph, or Gallam, the French settlement on the Senegal is about 150 miles, or five days' journey on foot. There are several islands on the Gambia, between M'Carthy's Island and the mouth.

The Island of St. Mary's is situated on the South bank of the river, opposite to Barra Point, where a battery has been erected, and where a few black troops are stationed; the breadth of the river is about 2 miles.

The island is separated from the main land by a very narrow creek, called Oyster Creek; the length of the island is about 4 miles, and the extreme breadth 1 mile. The total population of St. Mary's is 3,514 souls, resident strangers; of the fixed population, 42 are whites and 3,294 coloured people.

BATHURST is situated in the Island of St. Mary's; it is a small prosperous-looking town, with several excellent stone houses, especially on the wharf where the houses of the merchants are situated. In 1875, 233 vessels entered the port, including the visits of mail steamers. The whites nearly all return to Europe every year to avoid the bad season. They numbered only about 25 in the year 1875. *Jillifree* is on the North side of the river, and is about half a mile from Fort James.

Albrida, or *Albradar*, a fort which belonged to the French, is about half a mile from Jillifree; their possession of this place was considered not to be on any well-founded claim, and was also a very serious inconvenience and injury to the British trade in the river: but, as shown in the note on page 602, it has been exchanged for Portandik.

Of the Gambia, Sir Edward Belcher says:—"The Gambia, considered in a mercantile point of view, and, as regards supplies appears to offer more decided advantages than any of our possessions on the coast of Africa; and may, indeed be said to be the only point where anything approaching to trade can be satisfactorily pursued. Even in its present state it is by far the most healthy part of the coast; and, had a portion of the liberality of Government to Sierra Leone been extended to Bathurst and its dependencies, I feel satisfied that, long ere this, it would have acquired that character which eventually, with infinite labour, it will establish for itself from its own resources." The constitutions of the residents appear to be as sound as in any part of the world, and the strongest has been here thirty years without visiting Europe.

But it is to be regretted that, at Bathurst, the only fresh water to be had is from private wells; but, by close work in the dry season, as much as five tons a day may be obtained. Wood may be had at the beach, well dried, in convenient lengths for stowage, at a dollar and a half, or six shillings sterling, per cord.

Cape St. Mary is readily known by its making like a plain; low by the seaside, with an acclivity to toward the interior. It has some trees, one house for convalescents upon it, and an octagonal lighthouse.

The narrowest part of the mouth of the Gambia is between the town of *Bathurst* and *Barra Point*, to the N.E., the distance between being only $2\frac{1}{4}$ miles.

From Bathurst Point, the Banyan or St. Mary's Shoal, a dangerous rocky shelf, extends 5 miles N. by W. (*N.N.W.* $\frac{3}{4}$ *W.*). It is even with the water, on the ebb. At a mile to the N.E. of this is a bank called the *Middle Ground;* and at three-quarters of a mile northward of the latter, is a smaller one, the *African Knoll.*

Buoys.—Four buoys (1875) mark the entrance to the River Gambia. The *Fairway Buoy*, in lat. 13° 35′ N. long. 16° 50′ 10″ W., *chequered* black and white, surmounted by a white cage, lies in $4\frac{3}{4}$ fathoms, with Cape St.

Mary (centre of red cliff) bearing S.S.E. $\frac{3}{4}$ E. distant $9\frac{1}{8}$ miles; Middle Buoy E. by S. $\frac{3}{4}$ S. $5\frac{3}{4}$ miles.

Northern or *Red Bank Buoy* is *red*, surmounted by a black cage, and lies in $5\frac{1}{2}$ fathoms, with Cape St. Mary bearing S. by E. distant 13 miles; Fairway Buoy S.S.W. $\frac{1}{2}$ W. distant $5\frac{1}{2}$ miles.

Middle Buoy, painted *red*, and surmounted by a black cage, has been moored in $4\frac{3}{4}$ fathoms, nearly midway between Fairway and African Knoll Buoys, with Cape St. Mary bearing S. $\frac{1}{2}$ W., distant $5\frac{3}{4}$ miles; and African Knoll Buoy E. by S. $\frac{3}{4}$ S. $6\frac{1}{4}$ miles.

African Knoll Buoy is *black*, surmounted by a cage, and lies one cable off the north-west part of the African Knoll in 5 fathoms, with Cape St. Mary bearing S.W. by W. $\frac{1}{2}$ W.; the flag-staff at the north-east extreme of Bathurst S. $\frac{1}{4}$ W., distant $7\frac{1}{8}$ miles.

Vessels sighting the Northern Buoy, should immediately steer southward to sight the Fairway Buoy, from which Cape House may be seen in clear weather. From the Fairway Buoy, by steering so as to pass just northward of the Middle and African Knoll Buoys, the least depth found will be $4\frac{1}{4}$ fathoms. Nearer the Horse-shoe Bank the depth is 5 fathoms. Vessels should go no nearer to the Horse-shoe Bank than to the distance of $1\frac{1}{2}$ mile northward of Middle Buoy, as the shore is reported to have but a depth of 2 fathoms in places. From the Middle Buoy (*red*) the African Knoll Buoy (*black*) bears E.S.E. $6\frac{1}{2}$ miles, and after passing northward of the latter, within half or three-quarters of a mile distance, the town of Bathurst may be steered for S.S.W. about $6\frac{1}{2}$ miles, and anchorage taken up abreast the town.

When advancing to the Gambia, from the northward, you ought not to approach the river nearer than in 7 or 6 fathoms, before Cape St. Mary keeps in sight. It may be advisable for a stranger not to proceed farther than in 5 fathoms without a pilot, unless a vessel draws less than 12 feet of water. Those leaving Goree, when bound to Gambia, may steer about S. by E., keeping their lead constantly going, and approaching the coast no nearer than in 7 fathoms. When near the entrance of Gambia, the ground will generally be found an oozy sand; but, near the cape, sometimes sand and sometimes red shells will be found. The ebb in the river runs very strongly, nearly eight hours, but the flood is not so strong. Spring tides are very rapid.

Having approached within one mile of Barra Point, from which a small spit stretches off to about a quarter of a mile, keep over for mid-channel between that point and Banyan or Bathurst Point. You have, 8, 9, 10, and 12 fathoms between the two points, and good anchorage in 9 fathoms water, muddy ground, with Barra Point bearing N.E. by N., and Banyan Point N.W.

The flood tide sets to Barra Point, and the ebb directly on the Middle; be therefore very cautious during calms on an ebb tide.*

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* At the Gambia, in the season of the Harmattan, the rainy season had just terminated on the 9th of December. Upon this occasion the colours are hoisted and a gun is fired. On a second visit in May and June, 1831, the end of the dry season, symptoms of approaching rains with squall.—*Sir Edward Belcher.*

From Barra Point to Dog Island Point, on the same side of the river, the bearing and distance are S. ¼ W. (*S. by E. ½ E.*) 8 miles. The coast between forms a deep and shoal bay, and the flats extend from it into the middle of the river. From Dog Island Point and Reef the coast takes a sudden turn to the S.E. and E.S.E., and it trends from Dog Island Point to *Lemaine* or *Lemon Point*, S.E. ½ E. (*E.S.E. ¼ E.*) 2 leagues. On this shore, at half a league more eastward, is the French former settlement at *Albreda*, and at half a mile further is the English one named *Jillifree*. One mile south-eastward from Jillifree, on an islet in the river, is *Fort James*.

To go up to James Fort, which is 17 miles above Bathurst, you steer in mid-channel 2 leagues, with the town of Bathurst N. ½ W. [*N.N.W. ¼ W.*] This leads to a fair offing from Dog Island Point. The course hence, in the fairway, to abreast of Lemain Point, is S.E. ¼ E. [*E.S.E.*] 6½ miles; and thence to Fort James, E.S E. ¼ E. [*East*] 3½ miles.

In order to avoid the shelf which extends from the Banyan or western shore, approach no nearer to that shore, in turning, than in 5 fathoms; nor nearer the Barra side, when above Dog Island Point, than in 4 fathoms; but if near that point, then in 6 fathoms. Lemain Point should have a berth of a mile, as some shoals stretch from it. You may haul in and anchor before Albreda in 4 fathoms, half a mile from it, the ground shoaling gradually to within a cable's length of the shore.

After giving Lemain Point a berth, do not haul for the Barra shore till you are abreast of *Albreda*, for the flat continues to the eastward of that point to a considerable distance.

In 1826, the River Gambia, to the distance of more than 190 miles, from its entrance, was surveyed by Captain *Richard Owen*, R.N., with his assistants, Messrs. Tudor and Mercer. This valuable survey exhibits the depths of water all the way up to *Pisanea*, where remain the ruins of a factory, and where the tide, in the dry season, rises 3 ft. It appears from the survey that, at 3 miles above *James Fort*, this noble river is nearly 2½ miles in breadth. Here it takes a north-easterly direction, and thus extends for 10 miles to a point on the South shore called *Moota Point*, and a creek, *Jukarda*, on the North. The depths of this reach, in mid-channel, are 5½, 4½, 4¼, to 6, 6, and 7 fathoms. Pursuing thence an easterly course, its depths alternately shoalen and increase to a great distance.

From *Boonyadoo Creek*, or the Fourth River, which faces the mouth of the Gambia, to *Jukerda Creek*, above-mentioned, is a line of coast, 1 mile (*nautic*) in breadth, and 42 miles in length, the sovereignty of which was ceded to His Britannic Majesty, by treaty with the king and chiefs of Barra, signed at Jillifree, 15th of June, 1826. A small spot (400 yards by 300) occupied by the French, at *Albreda*, excepted.

From *Cape St. Mary* (the true cape) the coast stretches 11 miles W.S.W. to the *Bald Cape*, where *St. Anne's Bank*, with the *Tongui Rocks*, extend about a league into the sea, and include three sandy islets, called the *Byjols*.

Upon the coast of Cape St. Mary the ground varies all along, but it becomes whiter to the southward. When past the Cape you find a reddish sand, which, at 2 or 3 leagues more to the South, changes into a gray, then into a whitish, sandy bottom; and, about Cape Roxo, it becomes such

fine sand as that which is put into the time glasses. The varieties of ground extend from 25 fathoms in the offing to 5 fathoms off the shore.

The coast between the *Bald Cape* and *Cape Roxo*, in a distance of 20 leagues, is very low, with a sandy beach, and covered with trees. The middle part is one low and continued forest, with clusters of large high trees, at a distance resembling islands.

In sailing between the two capes, by keeping in 5 or 6 fathoms along shore, you will find that depth down to the entrance of the *River Casamanza*, 4 leagues to the northward of Cape Roxo; there you have only 4 fathoms, and the ground mostly red sand. About 2 leagues southward from that entrance, and abreast of a cliffy point, near which you may anchor, the ground is so clammy, about a musket-shot from the shore, in 2 fathoms of water, that the lead is brought up with difficulty.

The **RIVER CASAMANZA**, or Casamance, is situate about 16 leagues to the southward of Bald Cape. If a bar did not obstruct this entrance, the river might be navigated by frigates; but it can be gained only by a very narrow channel, having a depth of 2 fathoms, but it can be entered with ease by a steamer under proper pilotage.

The Portuguese, established on the banks of this fertile river, have ascended to the distance of many leagues from its mouth; they have several establishments on it, the principal of which are called *Zinghicor*, 45 miles up the river, and *Makia Kaconda*. They have carried on an advantageous trade, especially in ivory, rough hides, aromatic seeds, and dying woods, with the Feloop and other negroes, who inhabit the banks of the river.

There is a French establishment, *Carabane*, 5 miles from the mouth of the Casamanza, on the northern point. Toward this there are two passages, divided by the bar, which extends outward, to the West, nearly 4 miles. The deepest channel is on the South side of this bank, and has $3\frac{1}{2}$, 6, 4, increasing to 8, fathoms off the point. The river upward, which has a serpentine form, has been surveyed by Captain Boteler; and from his survey it appears that there is another French settlement, the factory of *Berrin*, at ten leagues up the river on the South side, and 4 leagues below Zinghicor, which is on the same side. The soundings in mid-channel, from the entrance to the latter place, vary from 8 to 4, 6, $3\frac{1}{2}$, 5, 6, $3\frac{1}{2}$, 8, and 5 fathoms. The French have placed another establishment at *Sejeu*, having purchased the land of the natives. In 1865, it was stated that the channels had considerably altered, and that little dependence can be placed in the charts.

CAPE ROXO (lat. 12° 21′) is improperly called a *Cape*, it being an obtuse point of *low land*, from which the coast takes an E.S.E. direction to the *River Cacheo*, or *Rio San Domingo*, the navigation to which is impeded by extensive shoals, called the *Cacheo Banks* and *Falulo Breakers*. The point or cape, when bearing E.S.E. or E., presents a down of white sand, of moderate height, covered with brambles. On one side of the points formed by the coast to the northward, are a number of tufts, of a remarkably *red* colour, and it is supposed that, from these tufts, the name of *Roxo* (Red) has been imparted to the headland, although they are distant from it about $2\frac{1}{2}$ miles.

M. Roussin says, that on all approaches to Cape Roxo, the soundings are regular, but the depth inconsiderable. From the River Casamanza, to the distance of 2 or 3 miles from shore, there is a depth of only 6 to 4 fathoms. At 10 miles to seaward are 8 and 7 fathoms; and at a short distance to the S.S.W. the first bank of the Bissagos is met with.

Cacheo, on the South bank of the river of that name, has been the chief Portuguese establishment between Cape St. Mary and Cape Verga, and was formerly very considerable. They carry on the same kind of trade here as at Casamanza. The country is singularly fertile and well peopled.

The mouth of the river is about 6½ leagues to the south-eastward of Cape Roxo, and the entrance is between two reefs. In proceeding for it, give Cape Roxo a berth of about 5 miles. Steer S.S.E. on soundings of from 4 to 5 and 6 fathoms, on a sandy bottom. Go close to the eastward of Cacheo Bank, which has 2½ fathoms of water on it. Continue S.S.E. until you see breakers ahead, and run straight for them, until you are in 5 fathoms of water. You will see a single tree bearing East, then steer E. by S., leaving a reef, which extends out about 4 miles from that tree, on your port hand. This reef, although it is said to have 2 fathoms on it at low water, breaks at half tide. Close into the beach, at the tree, there is a passage of 2½ fathoms, which is fit for small craft only. Continue your course E. by S., when you will be apparently 4 miles from the land on your port hand, and will come to a shoal called the *Mud Bar*, on which there is a depth of only 18 ft. at ordinary high water, but is only soft mud, and about two cables in breadth. You may then see a clump of palm trees (ten or twelve in number), bearing E.N.E.; and when these palm trees bear N.E. by E., you will be over the bar, and will have from 5 to 5, 7, 8, and 9 fathoms up to *Cacheo Fort*, by keeping in the middle of the river; and when abreast of the Fort, which belongs to the Portuguese, anchor in the middle of the river in 9 fathoms.

BISSAGOS and Bijooga Islands.—We have now arrived at the Archipelago of Bissagos and the Bijooga Islands.

This archipelago is an extensive assemblage of islands and shoals between the parallels of 10° 42′ and 11° 40′ N., and between the meridians of 15° 30′ and 17° W. Of the interior navigation among the isles little is known, and the hostile disposition of the inhabitants renders it probable that no complete survey of it can be made without danger.

The principal isles that constitute the archipelago are said to be sixteen in number, besides many islets, all surrounded by shoals, as shown on the chart.

The archipelago is bounded on the North by the *Jeba Channel*, or *Great Channel of Bissao;* and on the East by the *Channel of Rio Grande.* These channels were partially surveyed by the officers under Captain Roussin, in 1818, and Captain W. F. Owen, in 1826; and to their surveys we owe our knowledge of the navigation presently to be described. The southern breaker, called that of the *Bayadère*, was discovered in 1818, and is represented by M. Roussin in lat. 10° 42′ 56″, long. 16° 17′, and the mouth of the Eastern or Rio Grande Channel is 7 leagues more to the eastward.

Jeba Channel.—The main land, forming the North side of this channel, is intersected by several rivers, which divide it into islands. The first of

these is *Cacheo*, then follow *Jatt*, *Bassi*, and *Bissao*, of all which the land is low. But there is, near the S.W. end of Jatt, at 13 leagues S.S.E. ¼ E. (*S.E.* ½ *S.*) from Cape Roxo (lat. 11° 50′) a small but conspicuous isle, named *Cayo*, which is bold-to, and very useful as a sailing-mark. This isle, when on an easterly bearing, appears like three isles, but on nearing will be found to be connected with a flat, which is common to all, though intersected, at high water, by shallow lakes. Its soil is sandy, and mixed with flinty rock. The beautiful trees with which it is covered may be seen, in clear weather, at 3 or 5 leagues off. At 6 leagues more to the eastward (*E.S.E.*), off the S.E. end of Jatt, are several islets, called the *Ancoras*, which distinguish the western side of a river, bearing the same name.

The islands, generally, which border the Jeba Channel, are not high. The beach is generally of white sand, interspersed with black and red rocks, which, being covered with lava, are, doubtless, with the whole archipelago, of a volcanic origin. The are all well wooded to the sea-side; and the height of the trees, with their vigorous appearance, indicate that the soil must be fertile. The Island Bissao, on which the Portuguese are established, is not so thickly wooded as the others; but this is owing to the clearance they were obliged to make for their safety, as the isle is equally fertile with the rest. The large isles of the archipelago are inhabited by a race of negroes, known in the country by the name of *Papels*.

On the Rio Grande the Portuguese have several establishments. The settlements of Portugal, on the coast, do not extend beyond Cape Verga. The objects of trade consist chiefly in elephants' teeth, wax, hard soap, rough hides of every kind, dyeing and building wood, indigo, cotton, drugs, resin, and resinous gums, gold in small quantities, orchilla, &c.

The extremity, or N.W. part of the Bissagos Shoals, is composed of hard sand. From this extremity the bank and isles extend to the southward and south-eastward, 23 leagues, toward the Eastern Channel of the Rio Grande; and the flat, which is from 12 to 6 leagues in breadth, is interspersed with banks above and under water, and islands, either dry, or drowned and marshy, the detail of which is little better than unknown.

The North edge of the shoals of Rio Grande, adds Capt. Gamble, is in lat. 11° 40′, and we led round them in 11° 43′, carrying from 11 to 15 fathoms. The tide of ebb runs very strongly over the flats to the S.W.; and within the heavy breakers the ebb runs W. by S,, and the flood E. by N. The tide, at full and change, rises 12 ft.

Cape Roxo has already been described. Should you fall in with this point in the evening, come to an anchor, bringing it to bear North, as then you will be well laid, in order to proceed farther.

The outer part of the *Breakers of Falulo* bears S. ¾ E. (*S.S.E.* ½ *E.*) 17½ miles from Cape Roxo, and lies to the south-westward of the River Cacheo. The breakers are divided into two groups, and extend in a *true* E.S.E. and W.N.W. direction 3 miles. They are very steep-to, and close to them are from 6 to 3 fathoms. A merchant vessel may advance within sight of them, and thence proceed toward the Isle Cayo; but the best way of proceeding to the Jeba or Bissao Channel is as follows:—

From a point at 2 leagues to the westward of Cape Roxo, proceed S.W. by W. ¾ W. (*S.W.*) 12 miles; then haul up on the port tack, as at this

distance the depth increases. The next course will be S. ¾ W. (*S. by E.*) for 25 miles, which will bring you to the parallel of 11° 47′, where a depth of nearly 50 ft., with a muddy bottom, will be found.*

You now enter the channel of the Jeba, and will find that a run of 12 leagues E.S.E. ¼ E. (*East*) will lead to the South point of the Islet Cayo, the trees of which, as we have shown, may be seen at a considerable distance. All the space to the northward of this track is replete with banks, which extend to the main shore; but those of the Falulo are the only ones that break incessantly.

Proceeding thus, the depths will be found always regular, from 7 to 8 fathoms, and the bottom constantly of mud. It must be observed, that when entering the Great Channel, the northern banks should be approached in preference to the southern. As the former descend by a gentle declivity, they always warn a vessel when she is out of the channel, by each cast of the lead giving a gradual decrease of depth. The southern banks, on the contrary, are extremely steep; close to a depth of 40 ft. there will be found one of 25, on a bottom very unfit for anchoring.

In order to be assured that you are keeping the channel, keep constantly sounding, and observe, that in all the channels which separate the banks to the N.W. of the Bijoogas, the bottom is almost exclusively soft mud without any mixture. At each cast, therefore, when the lead sinks into the ground, you may be certain that you are following the proper channel, and the middle of it may be found by the lead sinking deeper, and being less easily extricated. If the bottom becomes hard, it is a certain proof that you are near some bank, and if the vessel has much way on her, she must alter course directly for that side on which the bottom is softer.

A vessel seeking or running for the anchorage off the Islet Cayo need not mind passing close to it. This part is perfectly safe to the beach, at half a mile from which there is a depth of 8 fathoms, on a soft muddy bottom.

The great Channel, on the meridian of the Island Cayo, is about 4 leagues in breadth; but this space is divided into three channels, by means of two banks, on which there is very little water. Of these banks the northernmost is the *Bank of Cayo*, having a depth of only 10 ft. on it, and lying 4 miles to the southward of the islet of that name. It is rather narrow from North to South, but its length from East to West is about 5 miles. The best of the three channels is to the northward of this bank, in which there are from 7 to 9 fathoms.

At the distance of 2 miles southward from the Cayo Bank is the *Bank of Carasche*, which breaks continually, and a part of which is dry at low water. Like the first, which extends *true* East and West, and its length is also about 5 miles. The least depth between the two is 9 fathoms. At 4 miles to the southward of the Bank of Carasche is the North point of the island of the same name, which forms part of the South bank of the Great Channel.

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* Vessels coming from the northward, after making Cape Roxo, may steer S.W. from that cape, in 8 fathoms, all along, until they catch from 10 to 12 fathoms, green oaze: then steer S.E. by E., taking care not to get into less than 6 fathoms on the port hand on Cachco Bank, &c.—*Mr. Swann, a pilot.*

There is a channel between the bank and the island, but the depth is irregular, and the bottom is bad.

On advancing for the Portuguese establishment at Bissao, and having arrived to the eastward of the two banks before mentioned, you may safely proceed 5 leagues S.E. ½ S. (*S.* 60° *E.*), and will thus coast the island of Jatt to its S.E. point, which, from the trees upon it, appears to be the highest part of the whole coast on the northern side of the channel. The course thence is S.E. by E. ¾ E. (*E.* 5° *S.*) 6 leagues, in which extent the *Ancoras*, situated to the S.E. of the island of Jatt, the channel between that island and Isle Bassi, and the southern part of the last island, will be passed successively to the northward; on the South you will cross a large bay, formed by the islands *Carasche* and *Corbelle*, will pass the Parroquet Island (*Papakawa*), lying to the eastward of the latter, and finally arrive on the meridian of the western point of the Island of Bissao, at about 3 miles from it. From the Parroquet Isles, the southern side of this channel is formed by a bank, several parts of which are dry at low water.

To the southward of the town of Bissao is an islet, called *Bonn;* and at 2 miles above this is another, called *King's Isle.* On the South side of the river is another, called *Arcas*, which is 7 miles from Bonn, and nearly on the same meridian. The latter on the eastern side of the channel to Rio Grande, is the distinguishing mark for that channel. From the S.W. end of the Isle Bissao the course to Bonn is East (*E.* 20° *N.*) This course runs parallel to, and within 2 miles of, the Island of Bissao, and passes over several patches, on which there are only 26 ft. at low water. These patches are to the northward of the eastern channel, the mouth of which is near the Island of Arcas, which is seen at the same time. They may be avoided by altering the course occasionally; but as the depth on them is not less than 26 ft., and does not experience any considerable rise, as they are of no great extent, a vessel may pass over them without any fear, and may shape a direct course.

At 3½ miles W. ¼ S. (*W.S.W.*) of Bonn, is the *Point* and *Grove of St. Martin* of Bissao, where the coast forms a slight elbow. This point is not to be approached with safety, nearer than 1½ mile by a large vessel. At 3 miles S.S.W. ¼ W. (*S.* 5° *W.*) of this point, and in a continuation of the line from Bonn to the highest point of King's Island, lies one of the knolls above spoken of. It is the easternmost to be met with on the course above stated. To the eastward of the meridian of Point St. Martin, the depth increases toward Isle Bonn. This knoll, with 26 ft. water on it, is a small bank of not more than 100 fathoms extent in every direction, having deep water to the northward and southward of it.

When a vessel is within 3 miles S.S.W. ¾ W. (*S. by W.*) from Bonn, she should steer direct for it, so as to pass within 209 fathoms to the eastward of the island. This part is extremely steep, having, at the above distance from it, a depth of 8 fathoms. From hence she should run between King's Island and the fort, and anchor in 6 to 8 fathoms, on a soft muddy bottom. Having doubled the Isle Bonn, the coast of Bissao should be approached nearer than King's Island, as the depth is greater, and varies from 6 to 7 fathoms. It would be superfluous to mention the necessity of sounding constantly in this internal navigation.

In March (1856) Captain Canal, of the French ship *Agly*, proceeding to Bissao, encountered a most powerful southerly current. He had allowed for 1½ knot, but having become entangled to the South of Carasche, he found that he had set at the rate of 3 *miles per hour*.—(See pages 337-8.) He had grounded on a shoal, and was compelled to cast overboard 40 tons of ballast to lighten the ship, and after five days he contrived to pass safely through the Archipelago to the North and East, and arrived at Bissao. He sent a boat out to sound, and by that and the colour of the water he managed to arrive without casualty. Bissao, he says, offers but few resources for fresh provisions.

BISSAO.—The Road of Bissao lies in the principal stream of the River Jeba, between the eastern side of the Island of Bissao and the small island opposite, called King's Island. This roadstead is perfectly safe in all weathers. It is so completely sheltered, that the sea is always smooth; and the bottom is of such a nature that with good ground tackle a vessel may ride there in any season. It is advisable to moor N.E. and S.W., as the tides set in this direction; and in the rainy season, as the squalls come from the S.E., the anchors, being thus placed, will bear an equal strain.

The Portuguese Fort stands at 100 fathoms from the beach, and is a square redoubt, flanked at the four angles by a bastion. The wall of the ditch, which on each face is about 100 paces in length, may be about 30 feet in height.

The watering place at Bissao is on the beach, at about 33 paces to the southward of the fort. It consists of several pits, dug about 4 ft. deep in the sand, and may afford sufficient water to fill thirty casks in twenty-four hours. This water before being filtered, coming from sand and rock, is not agreeable to the taste, although it has the reputation of being wholesome, and ot keeping well; nevertheless, it should not be drank without being acidulated, or purified by other means. It may be either brought on board in boats, or rafted off at high water.

Independent of wood and water, excellent bullocks, of about one hundred weight, at the rate of from twenty to twenty-five dollars each, have been had at Bissao; also goats, pigs, and poultry. There is also rice, maize, and yams, and some fruit, such as bananas, lemons, and oranges. These articles are exchanged for gunpowder, brandy, iron, clothing, and dollars, by applying to the governor.

Governor O'Connor says:—"Bissao, declining when I visited it last in April, 1855, has since then greatly deteriorated in trade and appearance. The old buildings, totally neglected, are sinking into ruins, the troops without barracks living in miserable mud huts, the port occupied by only a few colonial and coasting vessels, the market scantily supplied with the commonest necessaries of life, are indubitable evidences that the power and prestige of Portugal are rapidly on the wane in this part of the world."

The waters which surround the Bissagos are far from being supplied with fish, and it is erroneously affirmed, in some works on Africa, that amongst these islands cargoes of salt fish may be procured. Mud prevails too much in the bottom; and the few fish which are found are not even considered

wholesome. No dependence can be placed on this resource, between the Gambia and the Isles de Los.

Dr. Madden says, "Bissao is the great stronghold of the Portuguese slave trade. The island of this group, on which the Portuguese Fort and Factory are established, is situate at the mouth of the River Jeba, about 100 miles South of the Gambia."

Winds in the Great Channel of the Bissagos.—The winds here follow nearly the direction of the land, and vary their course according to that of the channel. In the Great Channel they vary from West to North; at the anchorage of Bissao they are generally from S.W., except in the morning, when they are from the northward. In the rainy season, which commences here in the beginning of June, and continues about five months, they blow from the S.E. with the tornadoes, as on the whole coast, and then, passing round by South, return to the northward. Whatever may be the direction of the wind, a vessel, with the assistance of the tides, may always find her way into or out of the Great Channel, and the working is extremely easy with the assistance of the chart, which should accompany these directions. The remark respecting the northern bank being approached in preference to the southern, should be attended to here; the islands to the northward being perfectly safe, whilst those to the southward are surrounded by very steep and hard banks. Large vessels should not approach nearer to the Isle Corbelle than 3 miles, nor to the line which connects it with Isle Carasche. All the space which lies between the island, to the southward of this line, is filled with banks, having little water on them, and the greater part of which lie in the channel. If it should fall calm, and it be wished to let a vessel drift with the tide, she must not be abandoned to it until she has opened the channel she intends entering.

Anchorage in the Jeba or Great Channel.—A vessel may anchor anywhere in the Great Channel, the bottom being of soft mud and excellent holding-ground, with the exception of one place at $2\frac{1}{2}$ miles to the southward of the Isle Jatt. Here the depth is from 20 to 22 fathoms, and the bottom of coarse gravel. In all other part of the channel the depth varies from 13 to 15 fathoms, without any sudden alteration.

Tides.—The usual prevailing currents on the coast to the northward of Cape Roxo are found to be complely changed on passing this cape. They have here no longer one only direction; and, in all channels of the Bissagos, are suspended by tides, which are more or less regular. Those in the Jeba, or Great Channel, are perfectly so. Westward of the Isle Cayo the flood sets S.E. and the ebb N.W., each six hours, or nearly so, with the exception that the current gradually assumes these directions, requiring nearly an hour, from the change, before it is completely settled in its course. The flood generally sets to the northward, and the ebb to the southward. The greatest difference which has been observed between the high and low water marks, is 8 feet; and at the equinoctial full moon the rate of the flood and ebb is about 1 2-5ths of a mile an hour; at other times it never exceeds 1 mile. At the entrance of the Great Channel, which is 6 leagues to the westward, and on the parallel of the Island of Cay, it is high water, at full and change, at $9^h\ 15^m$.

From the meridian of Cayo, and as far as that of the Isle Bonn, the stream follows the direction of the channel; and here the tides are regular. It is not known that the length of the ebb exceeds that of the flood. The greatest rate of either never exceeds 2½ miles per hour, in spring tides, and the rise is found to be 8 ft., as outside the channel.

On the meridian of Cayo it is high water, at full and change, at 11^h. Before Bissao the rates of the highest tides never exceed 2·6 miles per hour, and the rise is never more than 14 ft. In common tides the rate is never more than 2 miles per hour, and the main rise is 7½ ft. It is high water, at full and change, at the anchorage of Bissao, at 12° 30^m.

Channel of the Bolola, or Rio Grande.—The eastern channel, or Channel of the Rio Grande, branches into the Jeba Channel to the westward of the Island Arcas. The western bank is formed by a flat, which extends to the eastward of the Parroquet Islands and *Isle Galinha*, the banks which connect these with the *Hog Islands* and by *Kanyabac Island*. The eastern bank comprises the *Isle Arcas*, *Bulama*, or *Boolam Island*, and the banks which connect these two islands. It is then intersected by the mouth of the *Bolola*, or *Rio Grande*, after which it again commences at Bossessamé, and forms a chain of reefs as far as the Island Yomber, in 11° 3′ N., and 15° 40′ W.

The channel is then divided into two branches by a bank, which is about 4 leagues in extent from North to South, and on which, amongst several islets and breakers, are situated *Cavalho* and *Honey Island*. Seven miles to the southward of the latter lies *Pullam Island*. The western or main branch has, on its western side, the *Island of Orango*, and a long chain of reefs, which extend S.S.W. from that island.

To enter from the northward.—The first difficulty which presents itself, on entering this channel from the *northward* is when passing the Isle Arcas.

From the S.W. part of the island a bar stretches out, on which there is a depth of only 19 ft. at low water. It is terminated, at the distance of 4 miles, by a rocky bank, which also forms a part of the bar. Although the depth may be a little more at the distance of a mile from this bank, a large vessel should not venture near it without previously considering well the time of tide. If she be obliged to anchor, the best ground will be found near the meridian of Arcas, on the North.

The mark for running through this channel, from a position bearing W. ¼ S. (*W.S.W.*) from the Isle of Arcas, is to steer so as to keep the western point of the Island Bulama constantly bearing S. ¼ W. (*S.* 17° *E.*) until within 2 miles of the shore of this island. From hence, if it be intended to go to the southward, a vessel should steer for the middle of the strait formed by the island and Galinha; but should a vessel be bound to the northward, she should steer N. by E. ¾ E. [*North*] from the above bearing of Arcas, until she has passed the parallel in which it lies.

BULAMA, or Boolam.—The western end of Boolam may be approached within a mile. This island, which is well wooded and of moderate height, has several well-sheltered roadsteads, which afford safe anchorage. One of these, on the S.W. side of the island, has a depth in it of from 22 to 24 fathoms, with a bottom of soft mud. The configuration of the land is such, that the strength of the current, being carried more to the southward, is almost imperceptible at this anchorage; and although the tide rises from 12

to 15 ft., the sea is generally smooth and the landing easy. At this roadstead fresh water may be procured from two places.

The island, however, on account of its insalubrity, was abandoned for many years; till one of the slave dealers of the Havanna, a Señor Gaetano Nozzalino, obtained a Royal Portuguese Charter for settling on this island; and, in 1820, he established himself there. During ten years the island was in the hands of Nozzalini, it was frequented by slave dealers. But, in December, 1838, Lieutenant (aft. Admiral) Kellett, of H.B.M. *Brisk*, visited the island, attacked and destroyed the factory, and carried away 119 slaves, and subsequently carried away another batch of slaves, which the owner asserted were his domestics, notwithstanding the fetters with which they had been manacled were found amidst the ruins of the barracoon.

From the western point of Bulama the course is S. by E. ½ E. [*S.* 36° *E.*], the distance 3½ leagues. This course crosses the mouth of the Rio Grande, which separates Bulama from *Bossessamê*, or *Bessessema*, continues along the banks to the S.E. of Galinha, at the distance of a mile, the greater part of which is dry at half-tide, and extends to about 1½ mile from the banks on the western part of Bossessamé. The soundings on this track are very irregular, and vary from 35 to 8 fathoms, with a bottom, generally, of sand and gravel.

"On the right-hand bank, called Bessessema, are two settlements: one cultivated by a Frenchman, M. Henrique Orteau; the other a small location belonging to a vagrant English subject named Lawrence.

"The bank and grounds at Bessessema are cleared to a considerable distance; of a rich alluvial soil, they produce corn, kus, rice, ground-nuts, sugar-cane, yams potatoes, vegetables, tropical and *European* fruits, flowers in abundance.

"M. Henrique Orteau employs about 300 natives; has a well-built open town; the huts very lofty, with thick mud walls, and broad piazzas, are admirably calculated for the climate. He represented the place as healthy, and that even in the rainy season fevers seldom or never prevailed."—*Governor O'Connor*, 1857.

When at 2 miles to the westward of Bossessame, or Bessessema, a vessel may run for Kanyabac Island, steering South 3 leagues. The depth in this course varies from 7 to 20 fathoms, red sand and shells. To the westward of this track are the four little islands called the *Hog Isles*, and in the country, *Rouban*, *Banak*, *Chiccya*, and *Corett*. The latter, which is the northernmost, is the most remarkable, being covered with large trees.

KANABAC.—All the eastern side of Kanabac or Kanyabac is perfectly safe, and may be approached to within a mile, in from 6 to 10 fathoms. The S.E. point, which the inhabitants call *Barel*, is about 60 ft. high, very bold and formed in peaks. On rounding this point to the westward there is a small cove, called by the inhabitants *Port Manel*. It has a very good bottom for anchoring, but at low water a very small depth. This part of the Eastern Channel is formed by the S.E. coast of Kanyabac Island on one side, and a continued chain of banks, on which the sea breaks, on the other. The latter connect Bossessama and Yomber Islands, and have on them an islet of white sand.

Kanayabac Island, one of the most considerable of those which form this channel, is of moderate elevation, and rather higher on the southern than northern end. It presents alternately a sandy, volcanic, and ferruginous soil. If we may judge from the numerous population, and the quantity of cattle on it, this island must be very fertile.

The large trees, called in the country *Pullam Trees*, with palm trees, and vegetables of all kinds, are very plentiful on it.* The port of Manuel, lying between Point Barel and an islet called *Pomp*, seems to be the chief resort of all the canoes belonging to the inhabitants of the southern part of the island.

From *Point Barel*, near the middle of Kanyabac, the course is S.W. ½ W. [*S.* 30° *W.*] 13 miles. This will take a vessel within 2 miles of the western side of a very extensive bank which lies to the northward of the Isle Cavalho. The depth on this course is from 10 to 21 fathoms, the bottom of sand and shells.

From 2 miles West of the banks to the northward of the Isle Cavalho, the direction of the southern parts of the channel is S.W. ½ W. (S. 30° W.) This bearing, extended to a distance of 13 miles, will pass the eastern shore of Orango Island, at a proper distance, and also breakers which stretch more than 2 leagues off to the S.W. of this island, and to the parallel of Pullam Island, at 3 leagues from it. Orango Island is the most considerable of the Bissagos. From hence, any course between S.S.E. and S.W. by W. [*S.E.* ½ *S.* and *S.W.* ½ *S.*] will lead a vessel perfectly clear of all danger, and out to sea.

The eastern part of Orango is not very high, and is of the same nature as the adjoining islands. The most conspicuous point, when bearing N.W. by W. ½ W. [*W.* by *N.*] is a well-defined cape, much higher than the adjacent land, and remarkable from several spots of yellow sand, which form a striking contrast to the brown appearance of the coast. This cape, forming the S.E. point of the island, is called *Cape Cameleon*, or *Yellow Cape*. At 4½ miles to the East of it is a spot nearly dry at low water; but the depths between are from 5 to 11 fathoms

Pullam Island, which derives its name from that given by the natives to the large trees (Bombax, or silk cotton), with which it is covered, has not above a mile of extent in any one direction, and is very little above the level of the sea. Its shores are rocky, and rendered very difficult for landing, by the constant surf which breaks on them. It is impossible for large vessels to approach this island; from S.W. to E.S.E. it is bounded by flats, which extend to a distance of 4 miles from it, several parts of which are dry, or breaking.

The winds in the Eastern Channel are generally light during the fine season, particularly in the night or morning. They set in gradually in the

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* Captain (aft. Admiral Sir Edward) Belcher has noticed that the Pullam tree is the *bombax* or *silk-cottom tree*, and has no reference to the palm. *Pullam Island*, which will be presently described, as deriving its name from the "large trees with which it is covered," can hardly boast half a dozen palms, which hide their diminished heads beside the more majestic Pullam trees.

afternoon, and blow almost always from S.S.W. round by West to N.N.W., but they remain a very short time at any intermediate point, and soon follow the direction of the land, which, as well as we could determine, trends nearly N. by E. and S. by W. Easterly winds are limited entirely to the rainy season.

The tides are as regular in the Eastern as in the Jeba or Great Channel The length of the ebb is equal to that of the flood; the former sets to the northward, the latter to the southward, but the different points of the channel, and the irregularities of the bottom, affect those directions. The mean rise of the tide is from 12 to 15 feet. The strength of the stream varies according to the breadth and depth of the channel, being greater where it is confined than in the wider parts; it is consequently more considerable in the Strait of Bulama, and the Honey Island Channel, than in any other part. Nevertheless, it seldom exceeds $2\frac{1}{2}$ miles per hour, but is frequently as much as 2. At 2 miles to the westward of Pullam Island it is high water, at full and change, at $10^h\ 15^m$.

RIO NUNEZ.—*The River Kakoondee*, or *Kakundy*, commonly called the *Rio Nunez*, or *River of Nuna Tristao*, is a very considerable river, broad at its entrance, but impeded by several shoals, among which the least water in the channel is 3 fathoms. It has been celebrated as a place of trade for ivory. The situation of the entrance, as shown in the Table, is 10° 36′ N., and 14° 42′ W.

Between the mouths of the Rio Grande and the Rio Nunez the coast is very imperfectly known, but it appears to be, in general, shoal, and dangerous to a great distance from shore. On the edge of the bank, in lat. 10° 37′, and at 25 miles S.E. by S. (S.E. $\frac{3}{4}$ E.) from Pullam Island, is a rocky bank, called the *Alcatraz*, with a rocky islet in its centre. It is surrounded with breakers, and the reefs extend from it both to the N.W. and S.W. At 6 miles to the westward is a depth of 20 fathoms. Sir Edward Belcher has described the islet Alcatraz, the landing to which was not at all difficult, but the whole summit of the rock was covered with boobies (*pelicanus sula*), the eggs of which were procured. Alcatraz may be approached on the S.E. side; but the reefs stretch from it 5 miles S.W., *true*, and above 3 miles in width, at right angles to this bearing. Lat. 10° 38′, long. 15° 20½′.

Nearly in the route between the Alcatraz and the Rio Nunez, in lat. 10° 30′, and long. 15° 11′, is a much more dangerous reef, surveyed, in 1826, by Captain Owen, and by him named the *Conflict Reef*. Its western edge is 14 miles to the S.E. from the Alcatraz, and its breadth each way is from 3 to 4 miles. Two other rocky banks, to the southward of it, are comprehended within a distance of 8 miles; the South point of the latter is in 12° 20′, and has near it a depth of 11 to 16 fathoms. From this spot the mouth of the Rio Nunez bears about E.N.E. $\frac{3}{4}$ E. (*N.E.* by *E.*) 10 leagues.

The descendants of the Portuguese, who still exist on the banks of the Rio Nunez, are so mixed with the negroes, that they have been described as negroes themselves.

In the old charts of this coast no island is laid down at the mouth of the River Nunez; and we first learned, from the information of Captain Livingston, that a considerable island, where Woodville formerly gave a shoal,

had arisen within the last thirty or forty years. It is called *Sandy Island*, is now covered with trees, and has many palms upon it.

Sandy Island, according to Captain Belcher, is in lat. 10° 36′ 37″ N., long. 14° 42′ 19″ W. Seventy years ago it was a mere sand-bank, even at low water; subsequent deposition, however, has not only formed it into an island, at least 6 feet above high water, and bearing large trees, with a fair surface soil, but has also added a very extensive range of shoal on its northern, western, and south-western sides.

Vessels bound to the Nunez should make the land in 10° 31′ N.; or, if coming from the southward, should, at least, not advance into less than 7 fathoms till in that latitude. They will then approach the river, steering East (*N. 75° E.*) through regular soundings; and it is necessary to remember chiefly, that, with a flood tide, there is a dangerous rocky flat on the starboard beam going in, while, on the other hand, a vessel may play with the edge of the breakers on the point of Sandy Island on the port side. The constant warning also, "Keep in mud," which is familiar in all channels along this coast, should be here especially kept in mind.*

For a vessel to refit, no place can be better adapted than Sandy Island. It is uninhabited; and a vessel may be moored within 150 yards of low-water mark, or even less, if required, but should be prepared to haul off in case of a tornado. Small vessels may be grounded or hauled up for repair or examination; a space sufficient for the encampment of a crew, even of a line-of-battle ship, is free from trees; and stores may be conveniently landed. Immense quantities of drift-wood lie piled on the S.W. side; and plenty of live timber grows on the island, of which the palm yields an excellent cabbage for the use of the sick or convalescent.† Fresh water alone is scarce and ill-tasted; and a great annoyance arises from the clouds of fine sand which are incessantly in motion over the island. The temperature, when the *Ætna* was there, did not exceed 105° in the tent; which was, however, oppressive, from the necessity of keeping it pretty well closed, to prevent the sand from imbedding the instruments. A breeze generally prevailed throughout the day, except between nine and noon. The western side is by far the most cool and pleasant, but not so convenient for communicating with the ship.

The river is very serpentine in its form, and the trees on either side impede the wind in its true course. Still, however, a pleasant, and after noon, even a fresh breeze generally favours vessels bound up, and affords favourable slants in many of the reaches down. The general depth may be stated at 2½ to 3 fathoms at low water, with a rise and fall of about 12 feet; and although the lead generally gives mud, the anchor frequently hooks a rock, and good and long buoy ropes are especially necessary, which should be got on board the instant the tide slacks, in order to be in readiness to

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* *Captain Livingston* says:—In making the Nunez it is advisable to make it from the *southward;* but beware of the very dangerous *Sandkinsal Rocks*, extending 6 or 7 miles to the southward of Bencer or the East Point. The reefs and banks at the entrance of the river are certainly increasing, and generally break, even in moderate weather.

† This cabbage makes a delicious pickle, and is considered one of the finest anti-scorbutics in the world, doubly valuable when other vegetables are not to be had.—*E. B.*

trip the anchor instantly, if found to be foul. The change of the tide is very rapid, and much inconvenience will be felt if completed before breaking ground.

The three principal settlements *Walkeria*, *Cassasez*, and *Rebucko*, or *Debucko*, are all near each other, and from 70 to 80 miles up. We had formed great expectations of the supplies which could be procured at these settlements, but were much disappointed. Bullocks and sheep could be procured with some difficulty; fowls were very scarce; and vegetables could not be got at all. These native towns are never prepared to meet a sudden increase of demand for food.

Below Walkeria not a single habitation was observed on the Nunez, though the cultivation of its banks might be profitably pursued. The want of fresh water prevents the natives from settling here.

Above Cassasez, which is 2 miles above Walkeria, the river is much interrupted by rocks of close-grained basalt, several of them presenting a perfect columnar formation.

The range of the thermometer, while the *Ætna's* boats were in the river, March and April, was at six a.m. from 75° to 84°; at noon from 84° to 94°; and nine p.m. from 81° to 83°. The dews were slight; but at other seasons are said to be very heavy, accompanied by a fog, lasting frequently till noon.

The following observations on the Kakundy or Rio Nunez are from a copious and valuable communication by Captain Livingston, who visited the river in the year 1829.

To enter the *Nunez*, bring *Sandy Island*, above mentioned, to bear N.E, or perhaps a little (but very little) to the northward of that bearing, and steer in right for the island, which is bold-to on the South side. The shoals generally break, and extend about 5 or 6 miles, to the S.W. by W., or thereabout, from Sandy Island.

Giving Sandy Island a small berth, steer about N.E. for *Big Island*, which, in clear weather, may be seen after passing Sandy Island. Keep close to Big Island, as a rocky spit extends two-thirds or more, over from the *Talabunch* (Talabooncho?) or western shore. It is scarcely prudent for a stranger to run much above Big Island, but rather to send a boat up the river for a pilot, and one may generally be engaged at Walkeria, or a little higher up; or one may sometimes be had from a coasting vessel.

On going up the Nunez in a boat, be cautious not to mistake any of the creeks on the western side for the main river. Fresh water may always be obtained by digging a few feet deep at the root of any palm tree.

In going up the Nunez Captain Livingston grounded about three-quarters of a mile or a mile to the northward of Sandy Island. The vessel lay for two tides on fine sand without receiving any damage. When at anchor, on coming down the river, in 7 fathoms, about a quarter of a mile off shore, the centre of Sandy Island bore N. by W., and the extremity of the breakers on the long spit of sand, which extends 5 or 6 miles from the West end of the island, W. by S.

The situation of *Talabunch* (Talabooncho) village may known by some remarkable large trees, which may, in certain situations, be seen from sea, before Sandy Island can be descried. I have heard it remarked, that

wherever you see a large clump of majestic pullam trees (the cotton tree of the West Indies) you are sure to find a negro village; and wherever you meet with a palm tree, you may be sure of finding fresh water, by digging a few feet deep, however arid the soil may appear.

No person ought to land at Talabunch unless in company with eight or ten others, well armed, and on their guard; but on the opposite or eastern side, *Talabunchana*, the negroes, though of the same tribe, are remarkably civil and honest.

The Barrier of the River (as it has been translated to me from the Soozee language) is, I think, about half way up the river between Big Island and Walkeria. Ridges of rocks, almost like walls, and which appeared to me, when in a boat at low water, like walls of lava, extend about two-thirds across the river from the port or western shore; and at about a mile or a mile and a half above that, it is said that rocks, even worse, spit out from the starboard or eastern shore; but these were not seen in passing, when covered with the tide. There are other dangers in the river, but none of magnitude until after passing Walkeria and some houses about 2 miles above it, at Cassashe. These places are both on the eastern or starboard shore. Between them and the viliage *Rebucko* is a very dangerous spot; but vessels drawing 10 feet may proceed to the latter near high water.

Both banks of the Nunez are generally muddy; mangroves grow into the very water, and some of the finest tree or mangrove oysters adhere to their trunks and branches.

In the rainy season tornadoes are frequent and violent; but, with caution, vessels may have sufficient time to prepare for them. I observed none here to begin with small clouds or a small cloud, but all with heavy thunder clouds.

Vessels going to the Nunez ought to be well supplied with provisions, and not to depend on what can be obtained there, as a great scarcity frequently prevails. There are many cat-fish in the river, and above Rebucko some other kinds of fish. There are pike, similar to those of Britain, but with scales much larger.

The time of high water, on full and change days, at Walkeria, is $10^h\ 17^m$ a.m. Rise, from $16\frac{1}{2}$ to 18 feet or more. Depth, at low water, 15 feet; bottom of fine mud. Latitude of the wharf at Walkeria, by two meridian altitudes of Jupiter, agreeing to one second, 10° 54′ 22″; longitude, by 52 sets of lunars East and West, mean, 14° 18′ 55″ plus 3″ for distance of place of observation equal 14° 18″ 58″. The tide at Walkeria runs strongly, and while I was there flowed five hours and ebbed seven; but during floods in the river (which sometimes rise considerably) it ebbs or runs down longer.

Walkeria was named from Walker, a slave factor, who realized a large fortune and died here. This place is composed of thatched huts, mostly supported on stakes, though some have mud walls, and there are two of two stories each. The population may be from 500 to 600; all Mandingo Mohammedans, excepting the slaves. *Buoy Modé*, the chief, who speaks a little English, said he had five wives, but he wanted to get some more! His arms bore many *gris-gris* or charms (they called them gregories), and even his horse's neck was loaded with no small number of them.

RIVER COMPOONEE.—Captain (Sir Edw.) Belcher, in the prosecution of his survey, made out three mouths to the Rio Nunez, and 10 miles N.W. of the northernmost, much to the westward where land was expected, saw a cluster of islands, which gradually showed their close approximation to the main, and were ascertained to form the North and West boundaries of the entrance to a river or inlet, larger at its mouth than the Nunez; and, at 12 miles within the distance to which he surveyed it, deeper, swifter, and promising as large or larger branches. Where Captain Belcher stopped it came from the East, and showed several extensive arms leading to the North and West. The entrance by which he ascended has two large channels, equally navigable, but its mouth is so studded with shoals, that until better known, few vessels will probably venture into it; the natives North of the Nunez having also the general reputation of being dangerous. The western entrance is equally fair and navigable to the sea. The northern alone is very shoal, and probably passable for canoes only: several of these were seen at a distance, and one country schooner; from which, and the numerous fires at night, it seems likely that the banks are well inhabited, and have some traffic.

Upon a renewal of the survey in 1832, it was found that small vessels only could navigate this river without great risk, there being a chain of rees, which nearly bars the passage; but above this barrier the channel is sufficiently deep for larger vessels, and has few dangers.*

The coast from the Rio Nunez to Sierra Leone, in an extent of about 55 leagues, is in general low, in most parts swampy, and intersected with creeks, which, connecting the adjoining rivers, form an excellent navigation; but at unequal distances, from 5 to 20 miles, in a right line from the sea, the land rises gradually; and beyond that distance, in many places, towers into lofty mountains, which, after a tornado, when the air is pure, may be seen 10 or 12 leagues off.

A small isle, called *Young Gonzalez*, lies about 5 miles to the eastward from the regular entrance of the Rio Nunez. It is the southernmost of three, having channels communicating with the Nunez; about 5 miles true East from it is the mouth of the *River Coppatches*. From Young Gonzalez a long and dangerous flat of rocky ledges, gravel and sand, extends S.W. (by compass) nearly 6 miles. At low water, a patch, three-quarters of a mile in length, has over it only 6 feet of water. Its composition is a coarse red sandstone, or conglomerate, like lava, till broken. The *Coppatches* is a trading river, but shallow, and frequented only by boats, or vessels not drawing more than 4 feet of water.

CAPE VERGA, in lat. lat. 10° 19′, is the termination of some moderately elevated land, and not a mangrove island, as commonly described. A long and dangerous spit extends from it N.W. 6½ miles. In the deep bay within this no vessel can enter which draws more than 4 or 5 feet of water. This place is South (S. 21° E.), from the mouth of the River Coppatches.

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* Sir Edward Belcher has given a pleasing description of its course upward; for which see the Geographical Journal, vol. ii. pp. 287-8. In the upper part many indications of buffaloes, hippopotami, deer, lions, panthers, monkeys, &c., were seen.

The coast hence southward appears to be a great series of islands, some forming, others breaking up, so that in twenty years the aspect probably will be materially changed. The high mountains of Cape Verga, which stand about 3 leagues inland, to the north-eastward of the cape, serve as a mark for it, and may be seen at the distance of 15 leagues. Thus, bearing E. ¼ S. (*E.N.E.* ½ E.), they are equally useful to ships bound to the Rio Nunez, which, with this bearing, will clear the banks lying without the river at 5 or more leagues to the south-westward.

Of the mountains within Cape Verga, two, in particular, are the most conspicuous, and the highest, according to M. Roussin, is in lat. 10° 18′ 52″, long. 14° 21′ 20″. These mountains have no particular peak, but form nearly one mass, extending from N.E. to S.W., and are about 500 fathoms in height.

RIO PONGO.—The entrance of the Rio Pongo is about 24 miles S.S.E. ¼ E. (*S.E.*) from Cape Verga. The river is well-known as a place of trade on this part of the coast, and its consequence has been increased by settlements of slave-traders on its several branches. To the country are several entrances, or inlets, but all seem to be included under one general name, *Pongo* or *Pongas*; each is impeded by a bar of mud or sand; and the coasts, to the head of the several rivers, are entirely covered with mangroves.

The first of the *Pongas*, or entrances to the *Rio Pongo*, is about 10 miles to the south-eastward from Cape Verga. This is called the *Cossencey Bar*, having a shallow and dangerous entrance, though within are 4 and 5 fathoms of water.

The best channel in, for a stranger, is over that called *Rissing Bar*, or the *Mud Bar*, which lies in lat. 10° 2′. and extends more than 2 miles out from the river to the westward. On the North side of it are only 6 feet, on the South side from 6 to 9 feet, and on the middle 12 feet at low water. From this bar, two hills up the country, called the *Paps*, bear E.N.E., and serve as a mark for the river. A grove of palm trees, on the North side, is also a distinguishing mark.

To sail over the Mud Bar, get the river open, and steer in N.E. by E., keeping the Paps, which are moderately high, a cables' length open of the North point, by which you will carry 4 fathoms in depth at high water, or 2 fathoms at low water. Anchor in 7 or 8 fathoms, in the middle of the river, abreast the palm trees on the port hand, which trees appear to extend about 2 miles in length. Then send your boat up the river for a pilot, or fire a gun twice or thrice, at intervals of about an hour, and in all probability a pilot will come off to you.

If bound to this place in the night, approach no nearer than to the depth of four fathoms until daylight. If bearing in, stand no further to the northward than to bring the two hills in the middle between the two points of the river; then stand to the southward to 2 and 2½ fathoms, and proceed as shown hereafter.

If going in, with a fair wind, bring the North point of the river, with its palm trees, to bear N.E., and run in with it bearing N.E. by E. On entering keep on the South side, within the bar, as the flood tide sets on the northern breakers. Should you here have a quarter-less-two, you

need not fear, as the bottom is all of mud. The river hence lies East and West about 8 miles, and its depths, in mid-channel, are 3, 4, 7, 6, and 5 fathoms.

The *Sand Bar* is 5 miles to the southward of the Mud Bar, and its entrance is more intricate; therefore not to be attempted without a good pilot. This is, nevertheless, the mouth of the Rio Pongo, properly so called. In the best channel, at the entrance, the depth is 12 feet at low water, and within it are 4 and 5 fathoms.

A small sand-bank having showed just above water, at high tide, to the northward of the Sand Bar, and mangroves having taken root on it, the bank consequently increased, and the natives have planted palm trees on it. There is said to be a passage of 3 fathoms.

Vessels bound to the Pongas sometimes make the high land of Cape Verga, and sometimes go to the Isles de Los for a pilot, although one is not always to be found there. Some run in by their latitude, taking care to sound frequently, as soundings extend $1\frac{1}{2}°$ to the westward.

The time of high water here, on the full and change, is 9^h. The rise, about 10 feet.

Sand Bar of the Rio Pongo, N.N.E. ½ E.—A. Barkia Hill; remarkable table-land.

From the *Rio Pongo* to *Dembia River*, a place of some trade, and more to the south-westward, the distance is 8 leagues. Two leagues to the southward of the latter is *Sangaree River*, whence the land juts out to the *S.S.W., true*, 6 or 7 miles to *Tumda Point;* beyond which, to the eastward, is the high volcanic land named *Mount Suzos*; and westward are the *Ilhas dos Idolos*, or *Isles de Los*, at $2\frac{1}{2}$ miles from the point.

Mount Suzos has a regular conical peak, excepting that, on its southern side, at half-way up, there is a large protuberance. This insulated mountain, in lat. 9° 34′, is a certain mark for the Isles de Los during the rainy season. In the dry season the atmosphere is always so hazy, that the coast of the continent is seldom seen, even near these islands.

At about 4 leagues to the northward of Mount Suzos is another mountain, called the *French Mountain*, to which M. Roussin assigns the latitude of 9° 45′ 50″, and long. 13° 26′ 10″.

On the 25th of May, 1826, Captain Owen, when in lat. 10° 2′ N., saw the Suzos or Sangaree Mountains; one formed a sugar-loaf, between 4,000 and 5,000 ft. in height. Having been twelve days in the neighbourhood, on a previous occasion, it may seem strange that it was not then observed; but it was during the dry season, when there is always such a haze over the land, particularly in the day, that the view is always much limited; but in the rainy season every shower clears the atmosphere, and the most distant objects may be discerned.

ILHAS DOS IDOLOS, or Isles de Los.—These isles, which have already been mentioned, lie between the parallels of 9° 25′ and 9° 42 N., and between meridians 13° 46′ and 13° 52′ W. They are six in number, but only three are inhabited, the rest being little better than rocks. Those which are

inhabitated are extremely pleasant, and, in general, healthy. The eastern-most island, on which the English factory was established, lies nearly North and South, with a high wood-crowned hill at each end, which, when seen from sea, appears like two islands. It is 4½ miles in length. The road is on the eastern side; and, during the dry season, is very safe; but, in the tornado and rainy season, there is no security, unless in the goodness of anchors and cables.

Tamara, or *Footabar*, the largest and westernmost of these islands, is nearly semi-circular, rising on both sides from the sea by a gentle ascent, to a moderate height, and is covered with good timber trees. It is 5 miles in length, and the summit of its northern part is 465 ft. above the sea. That of Factory Island is 470 feet.

In a description of the Idolos, or Delos Isles, by the Baron Roussin, the Admiral says, the isles worthy of description are, Tamara, the Isle Idolas, or Factory Island, and Crawford Island, by the French called Isle Françoise. Tumba, on the East, is so connected to the continent by beds of sand, mostly dry, that it can hardly be considered as an island.

Tamara, may be seen in fair weather at the distance of 7 or 8 leagues. On approaching, it appears like a range of hills, thickly wooded; its elevation is moderate, with the northern part higher than the South. It is, in shape, like a crescent, with its concavity to the S.E., forming several fine anchorages and depths of 6 to 3 fathoms, at low water.

You may enter the roadsteads on the eastern side of Tamara, either from the northward or southward, only giving the coasts a berth of three-quarters of a mile, beyond which distance both the North and South point are quite clear. A reef, the *Arethusa*, surrounds the North point to the distance of a quarter of a mile. The western side is bold-to, and may be approached safely. Near the principal anchorage within Tamara is a spring of fresh water, where 80 hogheads may be obtained in 24 hours.

At the distance of 1½ mile S.S.E. from the South end of Tamara is an islet named *Coral Isle*, leaving a passage between of 9 and 8 fathoms; but, in the same direction at a quarter of a mile from Coral Isle, is a small but dangerous reef, which must be cautiously avoided.

The central island of the group is *Rooma*, or Crawford Island, the western summit of which is 300 feet in height. From this island to the N.E. are shoal flats, extending to the distance of 2 miles, toward the North end of Factory Island, leaving a channel between of only two-thirds of a mile.

The Isles de Los are of volcanic origin, being formed chiefly of hard blue and iron-coloured lava, with occasional masses of porphyritic hornstone of different elevations. Of the vegetable productions, the most remarkable are the palms, which furnish palm oil and wine, and the silk cotton tree. The natives also speak of a tree, the bark of which is an excellent bitter, but it was not seen.

The native belong to the tribe named Baccas or Barkas (query Bagos?), who also occupy other islands along the coast. A great similarity exists between their language and that of the tribes inhabiting the banks of the Nunez.

The *rainy season* here commences in April, and ends in December.

The Seasons:—To begin with January. About the 8th or 10th of this

month the *Harmattan*, or cold strong easterly winds, continue, with some strength, for about a week or ten days; after which, the land-wind and sea-breeze take place till about the middle of February, when the wind becomes continual and N.W. or N.N.W., till the last full change of the moon in March. The tornadoes generally begin and prevail, more or less, till May or June; then the rains set in, and are almost continual all July and August; they begin to abate in September, and go off in October, giving place to the tornadoes, which continue till about Christmas. During the rainy seasons the winds are mostly between South and West, or in the S.W. quarter; and the tornadoes always blow with prodigious force from the E.S.E. or thereabout, accompanied with thunder, lightning, and a deluge of rain. When a tornado has happened in the night, it is impossible to imagine the clear state of the atmosphere next morning; we have nothing like it in Europe.

Sir Edward Belcher says that the rainy season between the Gambia and the Isles de Los ranges in its commencement, between the 1st of April and the 1st of June; and terminates from the 1st to 31st of December. Off the Conflict Reef and Bijoogas, rains and tornadoes were experienced on the 12th, 14th, and 15th of May, 1831.

The flood, at the Isles de Los, sets to the North. The tide rises and flows as shown in the Table.

Coast between the Isles de Los and the Pongo.—(*Sir Edward Belcher.*) —Tumbo Point is about 2 miles distant from Factory Island; and is a long rocky flat, partly covered at high water, and divided from the main by a narrow channel, navigable for canoes at high water, but nearly dry at low, when the natives affirm that they can walk across, though the depth of mud makes this improbable. From this the main land rises gradually, and partakes much of the features of the Isles de Los, without, however, being quite so denuded or bare as the summit of Tamara. The whole interior is mountainous; the highest peak, of which we could obtain measurement, being 2,910 ft. above the sea. This mountain is called *Kakulimah*. Further on, the *Sangaree* or *Soomba Ridge* commences, and forms the entrance of the *Sangaree* or *Debrika River*. The highest point of which, Tikitee-chin, or, as pronounced, *Tikit-chin*, is 1,705 ft. above the sea. Its western point is called *Alligator's Point*, and off this the mud extends above a mile, dry at low water.

The whole of this bay is one series of flats and reefs; and no vessel drawing above 6 ft. should venture within a line drawn from Tumbo to Alligator Point. Vessels drawing 15 ft. should not, when working up along this shore, do more than open Crawford Island; and, to ensure good room, should even tack when the East End of Tamara opens the South end of Factory Island. Within these bearings the soundings are very regular, and nowhere less than 5 fathoms.

The entrance of the Sangaree River has 2 fathoms in it; but there is little inducement to ascend it, there not being the slightest trace of trade along its shores, nor any supplies to be procured from them, excepting wood. The water is scarce and bad. The *Ætna's* boat ascended 65 miles.

More to the North there is a small isle in the centre of a river called the Dembia, but which is, in fact, a mouth of the Sangaree. From this isle,

Alligator Point bears S.E., *true*, 5½ miles. The river will admit very small vessels; but the greatest depth is only 1 fathom at low water, where the sea curled.

The shores hence are thickly clothed with mangroves, and extend about 16 miles to the first acknowledged mouth of the Pongo, called *Tabourg* or *Old Pongo*, which is bordered to a mile out by dangerous breakers.

Directions for Sailing from Cape Roxo to the Isles de Los.

By the Baron Roussin.

The description of the Bissagos, already given (page 617), points out the course to be steered in order to double their S.W. extremity. A vessel starting from a point 4½ leagues to the westward of Cape Roxo, which will be a little without the medium of 17° 0′ 0″ W., to the parallel of 10° 40′ North, will be outside of all the dangers. From hence a course of S.E. ¼ E. (*S.* 68° *E.*) and distance 68 leagues, will lead her to the West point of Tamara Island. On this course the soundings will never be under 8 fathoms, until near the shore of the island; and those on the first course will be considerably more.

From the parallel of Cape Roxo to that of the western breaker, 11° 31′ 32″ North, at a distance of more than 4 leagues to the westward of the meridian of 17° 0′, the depth will increase progressively from 8 to 28 fathoms, and the bottom be entirely of mud. This remark may be depended on to show that a vessel is not far to the southward of the parallel of the Jeba or Great Channel; she cannot at the utmost be more than 10 miles from the positions already given. From this point, as far as the parallel of 10° 40′ N., the bottom is nearly free from mud, and on passing to the southward of the parallel of 11° 20′, very slight traces of it remain, but are succeeded by a bottom of fine white sand, sand and gravel, sand and broken shells, with a depth varying from 12 to 50 fathoms. A vessel, having left Roxo, and arrived in lat. 10° 40′, may thence steer a direct course for the Isles de Los.

The S.W. edge of the Bissagos follows a gentle curve from the western breaker as far as the southern one, that of La Bayadere. The bottom, in this part, presents a singular peculiarity. Amongst the fine white sand, sand and broken shells, sand and gravel, of which it is most frequently composed, a greenish-coloured sand is sometimes found. The depth decreases very gradually from 50 to 9 fathoms, from S.W. to N.E.

The remainder of the course to the Isles de Los passes over deep soundings as much as 50 fathoms at the point of departure, and the least depth is 12 fathoms. No precise rule can be given as to the changes in the depth along this track, nor as to the various nature of the bottom. It is known only that the ground, in the space passed over by this course, seems to be furrowed with channels, which, commencing from the southern extremity of the Eastern Channel of Bissagos, diverge toward different points between *S. W.* and *S.S.E.*, *true*. The furrows above mentioned appear to have been caused by the regular tides in the mouth of the Rio Grande, and prove, beyond a

doubt, that the outlet of the same channel is partly caused by that river. With respect to the nature of the bottom, M. Roussin says that he remarked the total absence of mud. The bottom is of fine sand, in some places mixed with broken shells, small pieces of brittle rock, and gravel, which appeared to be only a covering to beds of a whitish volcanic sandstone, into which the lance penetrated but 3 or 4 inches, and did not hold. A muddy bottom is not found until about 10 leagues to the westward of the Isles de Los, and then only in small quantity, till within a very short distance to the N.W. of those islands.

Tides.—In proportion to the distance from the mouth of the Jeba or Great Channel of Bissagos, either to the northward or southward, the tides lose their regularity. The interruption in the tides is evident in going to the southward, as, at a few miles South of the parallel of the western breaker, 11° 31′ 32″ N., they are no longer perceptible, even on the edge of the Bissagos.

Captain C. T. Rudge, ship *Jane Black*, December, 1856, says:—"It is my opinion that the current along the coast from the Bissagos Shoals to Cape Palmas is variable, and in the parallel of Cape Mount coming from the westward with S.W. winds, I have always found northing in the set, let the current be easterly or westerly. Ten miles off the land the current runs parallel to the land either way, strongest off the capes. I have commanded ships on the West coast of Africa 12 years and have found the currents very variable at all times."

Coasts between Isles de Los and Sierra Leone.—The portion of coast between the Isles de Los and Sierra Leone comprises an extent of 66 miles, and contains several rivers, islands, and banks, besides various inconsiderable creeks.

Between the Isles de Los and the sharp low point of Tumbo there is a safe channel, through which, by Capt. Owen's charts, ships may carry 3 fathoms of water, and which may be, at times, highly convenient to use, or even to run through the group; yet, without some good reason for so doing, it will always be advisable to go outside the islands, where certainly no dangers are to be met with.

In approaching this part of the coast it may be remarked, that though the 3-fathom boundary, in some places, extends to a considerable distance, yet the soundings are so regular as to give ample warning. A tumbling sea, at times, may prevail in a strong breeze, yet as no gales but the *tornadoes*, which are of short duration and off shore, are known upon this coast, a commander need never be alarmed; for there is always good anchorage under foot, and no long swell current to force the vessel into danger.

From *Tumbo Point* to *Matocong Island* the bearing and distance are S.E. by S. 23 miles. Tumbo Point is the S.W. extremity of an island bearing the same name, and separated by a very narrow high water channel from the main land. To the southward of this point the land falls back to the north-eastward about 7 miles, forming an extensive but shallow bay, at the bottom

of which is an inconsiderable stream, called *Tannaney River*, accessible to canoes only.

In the extensive bay between the Isles de Los and Matacong Isle no detached dangers exist. The coast is safe to approach, the soundings being gradual, and always affording good anchorage; and it is, in all parts, accessible to large ships to the distance of 6 miles, which generally may be considered sufficiently near to distinguish the land, and often to recognise the mouths of the rivers.

Mahneah River, about 12 miles E.S.E. from Tumbo Point, is at low water, scarcely accessible to the smallest coasting vessels, but the rise of tide exceeds 2 fathoms. The entrance is about 6 miles south-eastward from that of Tannaney, but the water between is very shallow; and a mud-bank, which extends south-westward from the West point of the entrance, is uncovered at low water, more than 2 miles from that point. A similar mud-bank lines the East side also, leaving the channel between above a mile wide, but carrying only from 4 to 8 ft. at low water.

To enter this river, it is necessary only to bring the western point of the entrance, while at the distance of 5 miles from it, to bear N.E. by E. $\frac{1}{2}$ E., and then steer toward it in that direction, until you get close to the S.W. mud-bank, when you may proceed along by the edge of that bank, in a convenient depth, according to circumstances. Within the river the depths at low water are from 6 to 10 ft. only.

The water discharged from this river must be very great, as the ebb tide runs out with great rapidity.

River Morebiah.—The mouth of this river is about 18 miles S.E. by E. $\frac{1}{2}$ E. from the Isles de Los, and about 7 miles northerly from Matacong Island; and, though its breadth within the points nowhere exceeds half a mile, yet it is far superior to the Mahneah, last described. Its entrance is narrow, and forms an elbow at the commencement, which, to render perfectly safe, would require two buoys, because the coast is destitute of good objects to serve as marks.

In approaching the coast abreast of the river, with its opening bearing E.N.E. $\frac{1}{2}$ E., distant about 9 miles, and Matacong Island S.E. by E. $\frac{1}{4}$ E., you will have 6 fathoms of water, on black mud; from this situation the depth will decrease gradually, on a bottom of the same kind, to $3\frac{1}{2}$ fathoms at the entrance of the channel. With the rounding of the land between the rivers Mahneah and Morebiah bearing N.N.E., the East point of the entrance E. $\frac{3}{4}$ N., and the middle of Matacong Island S.S.E. $\frac{3}{4}$ E., you will have that depth. From this position steer N.N.E. until the East point of the river bears E. $\frac{1}{4}$ S., and then stand in towards this point, or about East; but remembering that both flood and ebb set partially over the extensive shoals that form the S.E. side of the channel. Some of these, however, being dry at low water, and nearly so at high water, their steep boundary is nearly discernible. In the elbow of the channel the least depth is $1\frac{1}{4}$ fathom at low spring ebbs; this depth, however, continues but a short way; and, from the time of altering your course to the eastward, or steering straight in, you will seldom have so little as 2 fathoms. Beyond the East

point the depth varies from 4 to 6 or 7 fathoms, and for the extent of 7 miles up the river it appeared to be clear of all danger.

About 4 miles above the East point of this river, and on the same side, a remarkable round mass of granite rock rises abruptly, about 40 ft. from the water's edge. It is about 400 yards in circumference; others may be seen inland, and the natives assert, that several are scattered about as far as the *Suzos Mountains*, which, they say, are also of granite.

It is high water, on full and change days, at $7^h\ 40^m$, and spring tides rise 11 feet.

The contrast which this coast presents to the eye, in different states of the atmosphere, has been already noticed in pages 227, 228, and 632.

Matacong Island.—The beauty of this island consists in the luxuriance of the trees, the verdure of those spots which have been cleared away, and the gentle rise, which renders it a conspicuous contrast to the low swampy tract opposite. It is more than a mile long, and having been purchased from the natives by Mr. Gabadon, a merchant of Sierra Leone, is now established for rearing cattle. The island appears to be of lava, yet on its summit there are two large pieces of granite; but there is reason to believe that they have been artificially placed there.

Matacong is surrounded by mud-banks and rocks in all directions, so that no vessel of any burden can lie at anchor within 2 miles of it. The channel, which divides it from the main, is nearly three-quarters of a mile broad, but its muddy bottom, at low water, is left dry.

From Matacong Island to *Sallahtook Point*, a distance of $14\frac{1}{2}$ miles S. $\frac{3}{4}$ E., the general features of the coast are the same as those already described, but the mountains are too distant to be distinctly seen; here and there a *cotton tree*, with smooth trunk and spreading foliage, rises above the surrounding thickets, and serves to identify the locality of the coast to those who are acquainted with it; but a stranger can make the mouth of the river which he intends to enter by his latitude only, or by running the coast down from some known point.

From *Matacong Island* the coast trends to the eastward a little more than 3 miles, where it turns abruptly to the northward, and forms the West point of the mouth of the *River Forecarreah*, the interval being fronted with sand and mud banks, which extend more than 3 miles to the southward. The entrance of this river is above 2 miles wide, and the least depth is 1 fathom at low spring ebbs. To sail in, it will be necessary to pass close to the banks which project from the West point, but, at the same time, to be cautious in approaching them, as they are steep-to, and dry at low water. The outer sand will be apparent, even in fine weather, at any other time than high water, and, if seen, it may be safely skirted in 2 fathoms near low water, or in 4 fathoms at high water; and that you may not get in at the back of this sand, do not bring the highest part of Matacong Island to the westward of N. by W. $\frac{1}{2}$ W., until the West point of the river bears N.E. $\frac{1}{4}$ E. You may then safely enter, recollecting as a guide that you should always keep the western side aboard, off which, however, you will have to edge occasionally to avoid the banks; yet this river is of very little consequence, as a ridge of rocks nearly crosses it at a short distance from its mouth. The ebb tide is extremely rapid, and the overfalls in the vicinity

of the rocks are dangerous to those who do not possess a local knowledge of the river.

The RIVER MELLACOREE, which is (or was) of considerable importance in the timber trade, has better objects for marks than any of those already described, and the facilities of its navigation are greater, yet buoys are indispensably requisite to make this secure.

For entering the Mellacoree, observe that, at 8 miles off shore, there are 6 fathoms of water; and, with the river's mouth bearing E. by N., it will be fairly open. Steer toward it, in that direction, until the soundings have decreased gradually to about 3 fathoms at low spring ebbs, with the following bearings:—East point of Yellaboi Island, S. by E.; Sallahtook Point, distinguishable by the trees being higher than elsewhere, bearing S.E. ½ S.; Bentee Point,* known by a remarkable large tree, E. by N.; the outer point of Tannah River, E.N.E. ¼ E.; and the rounding of the land to the northward of the river, N.E. ½ N.; you will then be at the spot indicated by the outer anchor in the plan, and in the fairway. The *Middle Ground* is steep and dangerous, but the soundings on the southern side are gradual, though the mud-bank is very wide; borrow, therefore, rather on that side until nearly as far as Bellangsang Point, when you must haul over to the mouth of Tannah River, and there anchor. Higher up there are some patches of rocks in the middle of the river, but at low water they are seen, as well as the deep-water channel between them, which is one-third of a mile in breadth, with a depth of 7 to 9 fathoms. By keeping the East point of the River Tannah, bearing N.W. by W. ¼ W., you may pass through this channel in safety; and, there being no further danger, you may ascend the river to the factories established below Devil's Island, on the South shore; the general depth varies from 5 to 9 fathoms. Here it is high water, on full and change days, at $7^h\ 40^m$; spring tides rise 11 ft.

Besides the channel on the South side of the Middle Ground, for which directions have been given, there is also an inferior one to the northward; to enter which, when 5 or 6 miles off shore, bring the West point of Tannah River to bear E. ¾ S., and by carefully using the lead, you may proceed in with safety; for, although at its termination, it takes a slight turn round the N.E. corner of the Middle Ground, yet this is generally so well indicated that you can scarcely be deceived.

The *Tannah River*, which falls into the Mellacoree, is also navigable, though much smaller, and the tides are not so strong as in the main stream.

On account of the soft nature of the bottom, vessels may ground in several places in the vicinity of the Mellacoree River, without being injured; but a patch of foul ground, which surrounds the long reef of Sallahtook Point, must be carefully avoided.

From Sallahtook Point the coast trends S.S.E. 7 miles, to a small river, on the western point of which is situated Sangatook Factory; and about 1½ mile to the westward of this point is Yellaboi Island, surrounded by mud-banks that are dry at low water.

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* This point is on the South side of the river, and immediately opposite to another point, on which there are *two* very large trees.

Yellaboi is a low, swampy island, nearly 2 miles in length, and covered with trees, which, toward its western extremity, give it the appearance of an abrupt cliff, easy to be recognized; abreast the S.E. extremity of the river there is another small river, called Inglis Pahboyeah.

Corteemo Island.—Four miles S.E. from Yellaboi we come to a much larger island, with extensive mud-banks on the north-westward, but with a deep channel between it and the main; it is called *Corteemo*, and lies in the mouth of the Rivers Scarcies. These rivers are known by the names of *Great* and *Little Scarcies*; the former is navigable for large ships, but the other is adapted to very small vessels only, and requires very careful pilogage.

Great Scarcies.—The channel into the Great Scarcies River is the best on this part of the coast; for, although the banks are steep, yet it is broad and deep, and a ship of the line, by taking a proper time of the tide, might moor off the inner point of Yellaboi Island.

To sail into this anchorage bring the West end or highest part of Yellaboi Island to bear E.N.E. and steer toward it in that direction, until you decrease the depth to 5 or 4 fathoms, which will happen suddenly. Now change the course, and keeping in 4 to 5 fathoms, steer direct for *Inglis Pahboyeah River*, bearing E. $\frac{1}{2}$ N.,* taking care to keep it well open of the inner point of Yellaboi Island, until the West point of that island bears N. by E. $\frac{3}{4}$ E., when you must haul directly in toward it, and skirting along the steep mud-bank which borders the South side of the island, steer for its S.E. point, close to which you may anchor in $4\frac{1}{2}$ fathoms. In reaching this anchorage, the least depth you will have to pass over will be $2\frac{1}{2}$ fathoms at low spring ebbs; and this occurs only after hauling in for the island, and running along the edge of the mud-bank.

A timber-ship lying at this place, could easily have her cargo rafted down to her, excepting during the *rains*, when, as affirmed, the strong winds occasion so heavy a sea, as to make it unsafe to lie there with her raft ports open. With little difficulty, however, she might proceed to Kakongkah Island; though the channel is narrow and crooked, and would perhaps require buoys to point it out.† It would be scarcely possible to give intelligible marks for this winding channel, but it is so apparent in the plan, that by using the boat ahead, and never passing over the 3-fathom boundary line described therein, except in crossing the three short flats, you can scarcely go wrong; the bottom, however, is so soft, and the water so smooth, that no damage will arise from touching. It is high water here, on full and change days, at $7^h\ 10^m$, and spring tides rise 11 ft.

SIERRA LEONE, &c.—From *Yellaboi Island*, mentioned in the preceding page, the *Cape of Sierra Leone* bears S. by W. $\frac{3}{4}$ W. (*South*) 25 miles. This

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* *Inglis Pahboyeah River*—the entrance is nearly a league to the North of Corteemo Island.

† *Kakongkah* is a small isle in the mouth of Great Scarcies River, having a factory near its western extremity.

cape, with the coast eastward, forms the South side of the great river, bearing the same name.

The coast northward of the mouth of the river is low and level, bordered with a shoal bank 3 miles in breadth, and which has upon it several dangerous rocks; but on the South side the land rises into hills, which, forming one upon the other, tower into lofty mountains, crowned with perpetual verdure. These are, properly, the *Sierra Leone*, or *Lion Mountains*, which have given name to the river and country. From the foot of the hills, points of land, projecting into the sea, form excellent bays for shipping and craft, and convenient places for hauling the seine.

The mouth of the river, which is 2 leagues wide, is obstructed by an extensive bank, called the *Middle Ground*, but on the South side of this is a safe and deep channel for vessels of any burden. The latitude of the cape is 8° 30′ N.

Vessels bound from Cape Verde to Sierra Leone are recommended to gain soundings in lat. 9° 15′ N. on the grand bank which extends from the Bissagos to Cape St. Anne; and having gained bottom in 50 fathoms, gray sand, on the edge of the bank, to make a *true* S.E. by S. course, keeping in soundings until in lat. 8° 20′ or 8° 30′. Then make an East course good, and you will make the land of Sierra Leone, the mountains of which may be seen in *clear weather* 14 leagues off; but as, on this coast, the weather is generally hazy, it is seldom seen further off than 6, and frequently not more than 4 or 3 leagues; although, at the same time, a good observation may be had. This is occasioned by the constant vapours, caused by the sun, which ascend from the mountains covered with thick woods.

Appearance of Cape Sierra Leone, bearing S.E. by E., distant about 5 leagues.

In standing in for soundings, and approaching Sierra Leone, keep the lead constantly going, as the current sets in various directions, but generally tending to the eastward. It is requisite to be very attentive to this particular. Should you be standing in, in the night, in lat. 8° 30′, and shoalen your water from 20 to 18, 13, and then suddenly to 8 and 7 fathoms, you will be at the distance of 3 leagues from the river, and should immediately anchor and remain till daylight.

The danger on standing in for the cape is the *Middle Ground*, hereafter described, which extends 7 miles from the eastern shore, and nearly to the meridian of the cape, leaving an entrance only 2 miles broad. Having made the land of Sierra Leone, bring the cape, which may be easily known by a small negro town standing upon it, to bear S.E. by S.; then steer directly for it. At this place *pilots* for the river may be had.

A rock, called the *Carpenter*, lies at the distance of nearly a mile W. ¼ N. (*W.S.W.* ½ *W.*) from the N.W. extremity of the cape. This rock always shows itself by the breakers over it, and at half-tide may be distinctly seen. The flood-stream sets directly through between the cape and the rock. You may advance within half a mile of the rock; but those beating down the

river, with the sea breeze, and a strong ebb tide, must be careful and give it a good berth, as the ebb tide sets strongly between the rock and the cape. From the cape, a ledge of rocks extends in a direct line toward the Carpenter.

Cape Sierra Leone Lighthouse was completed in 1849, and shows a *red fixed light*. It stands on the extremity of the cape, and is 69 ft. in height. It bears from Carpenter Rock E. ½ S. by compass, and from the western edge of the Middle Ground, S.W. ½ S. Vessels, therefore, coming from the westward should be careful not to bring the light to bear more to the eastward than E.S.E. ½ E., and coming from the southward not to alter the course until the light is on that bearing; and coming from the northward should not bring the light more to the westward than S.S.W. ½ W., until King Tom's Point comes in one with the centre barrack, S.S.E. ¾ E., to avoid the Middle Ground.

Within the cape the general trend of the coast is nearly *true* East 6 miles, but it is broken by several inlets, which are called *bays*. Of these, the first within the cape is a small cove, of pleasant appearance, called *Cape Bay;* the next is *Pirate's Bay*, so named from being the place where the pirates formerly used to careen and refit their vessels; the third is *Whiteman's Bay*; the fourth, *St. George's* or *Freetown Bay*, whereon stands *Freetown*, protected on the hill-side by a fort, and above the fort, on the summit of the hill, are the new barracks. On the East of Freetown is *Susan's Bay*, and at a mile eastward of the last is *Thompson's Bay*, bounded on the East by Farran Point.

Freetown.—The general aspect of the country in the immediate vicinity of this colony, and the external appearance of Freetown, give a stranger, on arrival, an idea of salubrity and prosperity, which subsequent experience may not altogether realize, or, at least, reconcile with the result of further observation.

Its more striking features are the largeness of the scale on which the public buildings are constructed; the wideness of the streets, and the regularity of their lines; the number of stone houses, and the excellence of the roads; the abundance in the markets, the multitude of well-dressed negroes in these places, the variety of stalls and shops in their own quarter, well supplied with British goods; the cleanliness and the comfortableness of their small abodes, the size and structure of the principal church, and the numerous chapels and schools in the town and suburbs; and last, though not least, the admirable order that seemed to prevail amongst the negro population, without any apparent exercise of magisterial severity, or rigour of political restraint, to repress or control the people.

From ten o'clock in the morning till five in the evening a white man is seldom seen abroad; at the latter hour, the race-course and the promenade on the battery are frequented by equestrians and pedestrians; and, perhaps, no circumstance that strikes the attention of a stranger, makes so strong an impression on his mind as the general expression he observes of languor and debility in the looks of every individual he meets of European birth (with perhaps two or three exceptions) in the colony. The young and old, the acclimated even as they are deemed, who have had their seasoning,

either in one fever, or the periodical return of that malady, and have survived these attacks, show plainly enough the baneful influence of the climate, which leaves the features without vivacity, and frame without vigour, and the whole constitution apparently deficient in vitality.

The settlement of Sierra Leone was formed in 1787; and the new colony occupied a tract of about 20 miles square, and was peopled, in part, by negroes from America; and was increased by various additions from the West Indies.

In 1791, the tract of land that was ceded by the native chiefs, in 1787, to the British sovereign, was made over to the Sierra Leone Company; and, in 1796, Governor Macaulay enlarged the limits by an additional quantity of land towards the sea-side on the western boundary, obtained from a native chief called King Tom; possession of this was finally gained in 1801. At this period the colony did not extend beyond the peninsula, which is about 18 miles long and 11 broad. In 1824, a new sovereignty of the territory was purchased of the chief of the North Bulloms, on the North side of the Sierra Leone River. We have derived this statement from Dr. Madden's report; but in Colonel Doherty's remarks upon it, he states, that the limits of the colony are strictly confined to the peninsula. The resident population of the settlement in 1871 numbered 37,089, of whom 107 were whites.

River Entrance.—The *Middle Ground*, already mentioned, forms the North side of the channel into the river, which is half a league in breadth. The general depths in the channel are from 6 to 10 and 12 fathoms. From the cape the extremity of the Middle Ground bears N.E. $\frac{1}{4}$ N. (*N.N.E.*) 2 miles, and the bank extends thence eastward to the Bullom shore. The ground is, in general, composed of hard sand; and in some parts large stones. It dries in several places, at about the middle of half ebb, and at all times the sea breaks over it. On its eastern part there is a channel, but it is fit for small vessels only.

The *Bullom shore*, which forms the North side of the entrance of the river, is level, and covered with wood. On this shore, in lat. 8° 40′, is an islet, called *Leopard Isle*, whence the coast rounds to the south-eastward, nearly 12 miles, to *Tagrin Point*, and between are eight negro towns, of which the fourth, from the northward, is that of the King of Bullom. The edge of this coast is low, swampy, and bordered with shoals. In the river, eastward of Tagrin Point, is *Tasso Island* and several smaller isles, the formation of which can be understood only by reference to the particular chart.

Ships from the northward, when bound to Sierra Leone, should be careful how they approach the cape. They must keep their lead going, and not approach any nearer than 6 fathoms, until they see the high land. No one should stand in for the cape until he gets that high land to bear E. by S. $\frac{3}{4}$ S. (*East*), and, when he is 6 leagues off, he will see the cape making in a small low point, with a ridge of cocoa-nut trees close to the water's edge; and when within 3 leagues of the cape he may observe the Carpenter Rock, with the sea constantly breaking over it. You pass the cape within a quarter of a mile, in 9 or 10 fathoms. You will now open the first cove, called Capo Bay, and thence pass Pirates' and the other inlets which have been described. In all these bays excellent fish may be caught with the seine, and sometimes green turtle.

Having passed the cape as above, your course will be S.E. by E. ½ E. (*E.* ¾ *S.*) up the river; this leads clear along shore to Freetown, which is 3¾ miles from the cape. The general depths will be 12 to 18, 13, and 14 fathoms. In working to the northward, advance no nearer to the Middle Ground than in 7 fathoms.

To anchor off Freetown, bring the fort (*Fort Thornton*) to bear S. by W.; the East point of the bay, S.E. ½ E.; King Tom's or the West point, W. by N., off shore a little quarter of a mile, 15 or 16 fathoms, with mud. Moor with the best bower to the eastward. The watering place here is very convenient and the water excellent. You will fill your casks in the boat, with a hose which leads from a cascade. A *green light* is shown at the landing-place by night.

In sailing up beyond Freetown to Farran Point, or further eastward, you will find regular soundings, 14 to 16 and 17 fathoms. You may make free with the shore all the way up, as it is very bold.

Farran Point is remarkable. It is elevated, and has a house on its summit. In hazy weather, several vessels, on coming in, have mistaken this point for Cape Sierra Leone, although it is nearly 2 leagues eastward from the cape, and have thus touched on the Middle Ground. But Farran Point serves as a good mark for the mid-channel, between the Middle Ground and Carpenter, when kept well open to the North of the cape, and bearing S.E. by E. ½ E.

Vessels coming in more from the northward will clear the West end of the Middle Ground in 3½ fathoms, with King Tom's Point (West of Freetown) on with the central barrack, bearing S.S.E. ¾ E. (*S.E.* ½ *E.*)

The *tide* at Freetown flows, on the full and change days, at 7ʰ 50ᵐ, and rises 12½ ft.

During the rainy season the tide is very regular and strong, running 6 and 7 knots an hour, and the ebb sets rapidly on the Middle Ground. In the dry months it commonly flows on shore at 7ʰ 30ᵐ, with seven and a half hours' ebb, and four and a half flood. In this season the ebb runs 2½ miles an hour, the flood only 2.

Sierra Leone to Cape St. Anne, &c.—From the Cape of Sierra Leone the coast, at the foot of the mountains, forms a slender sandy bay, bordered with trees, which extends more than 3 miles to the southward of the cape, where it terminates in a rocky point. At three-quarters of a mile further is another point, more conspicuous and projecting, named the *False Cape.* The last bears from Cape Sierra Leone S. by W. ½ W. (*S.* ¼ *E.*), distance 4 miles.

From False Cape to York, or the Sisters' River, the coast trends irregularly S. ¾ E. (*S.S.E.* ½ *E.*) 12 miles; and from York to Cape Chilling, S. ¾ W. (*S. by E.*) 7 miles.

At Cape Chilling the hills of Sierra Leone terminate, after having made a high double land, which is seen a great way off; the mountain near the South is of a prodigious height, its summit being perpetually covered with clouds, and can be perceived at the distance of 14 or 15 leagues. The cape itself is low, and covered with trees; and at 4 or 5 leagues off appears like a small island. Upon this cape is *Kent Town,* a village of liberated Africans

and disbanded negro soldiers; but, as no sure market exists for their industry, they raise little from the soil except for their own use. This village is delightfully situate on the side of a hill, with a large house for the superintendent.—*Capt. Owen*, 1826.

BANANAS.—Off Cape Chilling, and separated by a space of 2 miles in breadth, lie the Banana Isles. The outer or S.W. end of these isles is 7 miles S.W. by W. ¼ W. (*S.W.* ½ *S.*) from the cape. The greater part of their coast is foul and rocky.

The Bananas very much resemble the Isles de Los, but the land is more elevated. They are extremely fertile, and have plenty of water, but no running streams. Wild cattle are abundant upon the greater isle. It is a remarkable fact, that pigs are the only domestic animals that cannot be propagated here; as there appears to be some herb, of which they are immoderately fond, but which is fatal to their existence.

A few years ago H.M.S. *Tartar* anchored off Cape Chilling and to the northward of the Bananas, with the N.E. point of the isles S.S.E. ½ E., and the western part S.S.W. Between the ship and islands the water deepened to 8, 9, and 7 fathoms; but within a cable's length of the shore, between the westernmost island and the next, there was found a depth of only 2 fathoms. The westernmost islet was then inhabited by only one Frenchman, *Jean Baptiste Major*, and his four slaves.

East Point, S.S.E. ½ E. * *West Point, S.S.W.*

The Bananas appeared as above, from the *Tartar's* anchorage, at the distance of 4 miles.

There is anchorage as well to the southward as to the northward of these isles, but the best is said to be in 5 fathoms, about 2 miles from shore, on clear clayey ground, with the N.E. point S. ½ E., and the highest hill S. by W. ½ W. There are sandy bays, which may be seen from the anchoring-place, and where you may land; but the best is at the S.W. end. Wood and water are obtainable here. The watering-place, which is close to the beach, has a very good run of water.

Mr. Woodville has said, "It is very evident that the whole chain of mountains called Sierra Leone, as well as the Isles Bananas and the Isles de Los, are volcanic productions, if we are to judge from the great quantity of lava found there, and from the small pieces of it taken up by the lead, in sounding, at certain distances from the land, opposite to these islands, and nowhere else; also from the conical figure of many of the hills, and from the ferruginous soil in the country."

Yawry Bay.—At 6 leagues S.S.E. ¼ S. (*S.E.* ½ *S.*) from Cape Chilling is *Point Tassa*. The coast between forms Yawry Bay, the shore of which is bordered with a shoal 4 miles broad, having on it many oyster beds. Great part of the bank is uncovered with the ebb, and has only 4 ft. over it at high water.

Off Tassa Point is a group of islets and rocks, called the *Plaintain Isles*

and *Bengal Rocks*, which extend from the point 5 miles westward, on the flat between Yawry Bay and Sherboro Inlet.

Tides.—The tides divide off the False Point of Sierra Leone. To the northward of that point the flood runs to the northward; to the southward of that point it sets to the South. Hence, at the Bananas the flood is from the N.W., and the ebb contrary. Here the tide flows, on the full and change days, at $8^h\ 15^m$. During the equinoxes it rises 9 or 10 ft. perpendicular; other spring tides 8 or 9 ft. At the Plaintain Isles it rises about a foot and a half more than at the Bananas; but at the Bashaw or Turtle Isles more to the southward, the rise is 6 or 7 ft., common spring tides.

SHERBORO INLET,—The Inlet or Sound of Sherboro, commonly called Sherbro River, is between the island of that name and the main land. The westernmost headland of the island is *Cape St. Anne*, in lat. 7° 34′, and nearly on the meridian of Point Tassa, which lies in lat. 7° 55½′.

From Point Tassa the coast, forming the North side of Sherboro Inlet, trends 12½ miles S.S.E. ½ E. (*S.E.* ¼ *E.*) to the mouth of a river, the *Yallucka*, and thence it winds to the south-eastward, 6 leagues further, to the *Bagroo River*. It is bordered by a mud-bank, off which are several shoals, the positions of which can be understood only by reference to the particular chart.

The South shore of Sherboro Inlet is the North shore of Sherboro Island, which is 3 leagues in extent, from Cape St. Anne on the West, to *Jamaica Point* on the East. On this shore, at 12½ miles eastward from Cape St. Anne, is the spot and remarkable tree called *Little Pow Grande*, and 3¼ miles more to the East is *Pow Grande*. At 1½ league eastward of the Pow Grande, on the shore, is *Jenkin's Village*, off which is the general roadstead for large vessels, having 5, 6, and 7 fathoms of water. All the shore between this and Cape St. Anne is bordered with an extensive mud bank.

Bashaw or Turtle Islands.—On a great flat, which extends more than 4 leagues to the N.W. from the western end of Sherboro Island, is a group of eight or nine islets, called the *Bashaw* or *Turtle Isles*, which are evidently the remains of a considerable tract of land now submerged by the sea. The bank on which they exist also exhibits innumerable ridges, knolls, blind channels, and pools; but is navigable on almost every part by large boats at high water, and at low water by light boats and canoes.

Directions for Sherboro Inlet have been given as follows:—From off the West end of the Bananas, steer toward the Bengal Rocks S.S.E. ¾ E. (*S.E.* ½ *E.*) 14 miles, and so as to give them a berth of about a league; having rounded these rocks, steer S.E. ¾ S. (*S.E. by E.*) 5 leagues, taking care to avoid the hard sand-bank on the East, which is steep-to. In running on, you may shoalen your water to 4 fathoms, on the flat of Yallucka River, upon the eastern side, and thence continue the same course, 4 leagues further to the southern bank, making due allowance for tide, whether ebb or flood. The last course will lead to 1½ mile from shore, in about 4 fathoms of water, and without the edge of the bank. You may now run up along shore, for 2 leagues, to *Jenkins*, taking care to avoid the edge of the Middle Ground on the North, which here leaves a channel of only half a mile between it and the shore.

Bank and Shoals of St. Anne, Etc.—The *Bank of St. Anne*, which has not yet been thoroughly surveyed nor defined, may probably extend from the parallel of 8° to 7° 31½′ N., and from long. 13° 6′ to 13° 32′. The northern limit, as shown in the Table, p. 34, is 7° 56′; this is the limit to which the bank has been actually surveyed; so likewise the western limit is given in 13° 29′, where there are 10 and 12 fathoms of water; but 13 fathoms have been found at 7 leagues more to the westward, upon the general bank of oundings extending from shore; and there is a spot of 8 and 9 fathoms in about 7° 56′ N., and 13° 48′ W.

Upon the Bank of St. Anne are a number of small and dangerous insulated shoals, separated by channels of 6, 7, 8, and 10 fathoms. The bank itself is divided from that of the Turtle Isles by a narrow swashway, having 5, 6, and 7 fathoms.

But it appears that a vessel bound from Sierra Leone to the Windward Coast will clear every danger by proceeding over the great bank S.W. ¾ W. (*S.W. by S.*) 12 leagues to the parallel of 8° N.; and thence, on the meridian of 13° 40′ to lat. 7° 30′, from which point a course S.E. by E. ½ E. (*E. ¾ S.*) 22 leagues, leads to the *Shebar*, or Bar of Sherboro River, at the S.E. extremity of Sherboro Island.

Captain Midgley recommends that, "in the wet season vessels should give the St. Anne shoals a large berth to the eastward, as the current, as well as the sea, runs with great velocity into the bight of Cape Mount, and vessels which may unfortunately happen to fall in with the land to the northward of Sinou, in the wet season, will find considerable difficulty in working to the southward.

When Lieut. Badgely, with other officers and two boats, in 1820, proceeded from Great Turtle Island, in order to survey the southern part of Sherboro Inlet, they found a good channel, with about 6 fathoms, but the atmosphere was so thick that the object was totally defeated.

The *Boom Kittam River* runs in a parallel direction with the shore, at a distance from it of 1 or 2 miles. The strip of land between, called *General Turner's Peninsula*, is 8 leagues in length, and it is terminated by the Forks, in long. 12° 8½′ W. At 6½ leagues further to the S.E. is the *River Galinhas*, or *Gallinas*.

GALLINAS.—The bar of this river is only passable for large boats or small coasting craft, and is very dangerous during the rains, when it is frequently impassable. During the dry season it may be generally passed with safety, excepting occasionally at the full and change of the moon, which has a very marked effect upon the surf on the whole of this coast.

After passing the bar, the river opens out into a spacious sheet of water, about 3 miles across in every direction, which is studded with islands formerly occupied by the slave dealers, and affording very favourable situations for trading factories.

From hence the river runs, in three branches, to the north-eastward, to the northward, and to the N.E. The first, during the rainy season, joins the Boom Kittam River, thus affording a direct inland water communication with Sierra Leone; but in the dry season, at about 8 miles up, is too shallow for canoes to pass. The next branch runs past the town of Ghindamar (where the king resides), 9 miles from the sea, and is navigable about 5 leagues

for large canoes. The third branch runs close inside the sea-beach to the S.E., about 4 miles, and then turns suddenly to the N.E. at a place called Soolimane; from hence it is navigable for large canoes about 7 miles. This branch forms the S.E. boundary of the Gallinas territory. To the N.W. it terminates at a place called Casi, on the banks of the first branch, known by two conspicuous round trees, which form the principal landmarks in this quarter. These limits comprise about 12 miles of sea coast.

The coast here is very low and remarkably uniform, and for this reason three baobab trees near the mouth of the Gallinas are an excellent landmark. At about 6 leagues south-eastward from the mouth of the Gallinas is that of another small river, the *Manna*, off which you may anchor in 9 or 8 fathoms: this mouth is shut up by the beach, on which there is always a great surf. It is sometimes called Roc-Manna, from the unusual circumstance of the shore being covered with blocks of black rocks. At 8 miles further eastward, passing several villages or factories, you find the little *River Sugury*, beyond which is the bight formed by *Cape Mount*, having from 10 to 14 fathoms of water, with a bottom of black mud.

From the River Gallinas to Cape Mount the coast is very low, and covered with trees. It has a fine sandy beach all the way. At 5 or 6 miles off are regular soundings, from 15 to 18 fathoms, mud and sand, until you arrive at Cape Mount. H.M.S. *Tartar*, Sir George Collier, anchored in 15 fathoms, muddy bottom, Cape Mount bearing S. by E., and a remarkable large clump of trees North. Merchantmen anchor further in, at 9 and 10 fathoms.

CAPE MOUNT, which may be seen at 9 or 10 leagues off, is a promontory of high hills, projecting into the sea, the highest peak being 1,066 ft. above the sea; on each side the land is low, rather highest on the North side, with a flat sandy beach to the eastward. The cape itself is distinguished by cliffs, which may be seen 4 leagues off. It is very remarkable, especially in coming from the westward, when it first makes like an island, and contrasts greatly with the low and uniform coast to the West of it.

To fall in with Cape Mount, you ought to keep in the latitude of 6° 40′, having, on account of the current which sets toward the shore, frequent recourse to the lead when you think yourself near the land. In the night you may not approach nearer than to 26 fathoms, unless well acquainted.

To the westward of the cape lies the Road, into which you may run, until the point of the cape bears South and S. by E. There, in the summer season, that is, between October and May, when the weather is generally fair, is anchorage in 9, 8, 7, and 6 fathoms, sandy ground; but it is more common to lie in 15, 14, 13, 12, and 10 fathoms, because the tornadoes and southerly winds sometimes make a very hollow sea. The watering place is near a large tree in front of the outer point of the cape; and here, in the fine season, you may take in water with great facility.

In coming ashore with your boat, you must bring a hawser with you, and fasten one end of it to the land, the other being dropped with the anchor to seaward, so that you may prevent the breakers by it; for as you run directly against the flat beach below the town, without any shelter of banks or cliffs, in the morning, you may easily get ashore with smooth water.

To the northward of Cape Mount there is a river of the same name, which has been celebrated for its trade. There is 7 feet water on the bar at low

water, and 13 at high water; the current runs very strongly out, and the best time for crossing the narrow bar is at half flood. Between the cape and the entrance of the river there is good riding in the bay, during fine weather, in from 15 to 6 fathoms; but from 14 to 12 fathoms should be preferred in the rainy season, and even there it is hazardous, unless provided with the best ground tackle; for southerly and S.W. winds, in that season, set into the bight with a tremendous sea and heavy gusts, which raise a violent surf on the shore, that may be heard at a great distance.

Those approaching from the westward by night, without a previous sight of land, must take the precaution of sounding in time, in order to avoid the danger arising from the velocity of the current. As there are 15 fathoms close in-shore, you should not advance by dark nearer than in 20 or 25 fathoms. The same precaution should be taken during the *Harmattan*, when the sun is obscured by haze for days together, and the current varies.

CAPE MESURADO lies about 14 leagues S.E. $\frac{3}{4}$ S. (*S.E. by E.*) from Cape Mount. Hence its latitude is 6° 19′ N., in longitude 10° 49′. Between the two capes the coast is very low, with a white sandy beach, above which the land is covered with trees of varying colours. About 3 leagues to the northward of the cape is the *River of St. Paul*, navigable for boats only; but ships may lie off it at pleasure, in from 16 to 6 fathoms, good ground. The depth of 10 fathoms is nearly two miles from shore.

Cape Mesurado, though not so high ns Cape Mount, is an elevated promontory, almost perpendicular on the North side, but with a gradual declivity towards the sea on the South. There are regular soundings, of 20 to 15 fathoms, muddy bottom, at 8 miles off-shore, along which the current sets strongly. At 2 or 3 miles off-shore, with the cape S.E. by S., is a depth of 15 to 10 fathoms, muddy bottom, and a common anchorage. With the cape bearing N.E., the land appears like an island, with trees rising out of the water to the North; and at 7 leagues off it appears in its insular form, the land on each side being very low.

The *lighthouse*, a red tower 40 ft. high, shows a fixed light, at an elevation of 240 ft., and consequently ought to be visible 15 miles off, but it is a very bad light, and stated to be *uncertain*. In 1874 it was out of order, and in its place a lantern light is shown on a flagstaff 20 yards S.W. of the light-tower.

MONROVIA, the capital of Liberia, contains about 300 houses, and 2,000 inhabitants, and is built on a depression of the ridge which sweeps inland from the cape.

From its fine situation it is more salubrious, and far preferable to Sierra Leone. It is the outlet of the products of the St. Paul to the North, to which it is connected by *Stockton Creek*. The settlements of *Caldwell*, &c., on the St. Paul, showed every indication of comfort and prosperity; far more so than in Monrovia.

The Description of the Coast of Guinea, from the River Gallinas eastward, with directions for the same, is given in the *Sailing Directory for the Ethiopic or Southern Atlantic Ocean*, Eighth Edition, p. 537, &c.

THE ISLANDS OF THE NORTH ATLANTIC OCEAN.

3.—THE AZORES, OR WESTERN ISLANDS.

THE AZORES, or Western Islands, are nine in number, and named Santa Maria or St. Mary's, St. Miguel or St. Michael's, Terceira or Tercera, S. Jorge or St. George's, Graciosa, Fayal, Pico, Flores, and Corvo. The land is, in general, high; the coasts steep and rocky.

These islands are said to have been discovered about the middle of the fifteenth century by Joshua Vandenberg, of Bruges, in Flanders, who, in a voyage to Lisbon, was driven to them by stress of weather. At Lisbon, he boasted of his discovery; on which the Portuguese, in that spirit of enterprise so strongly manifested by them at this period, set sail and took possession of them, calling them *Acores*, or *Isles of Hawks*, from the many hawks and falcons found amongst them. It appears that they were entirely destitute of inhabitants, and of every animal excepting birds. The latter were numerous and of various species.

Antonio Gonzalo says, that the great Don Henry, Prince of Portugal, considered these isles as so considerable an acquisition, that he went in person to take possession, in 1449. This was forty-three years before Colombo landed in America. And it has been affirmed that the Flemish merchants, on the part of their countrymen, sent a conlony thither, many of whose descendants continue in Fayal to this day. Hence the isles have been also called *Flamingos*, or *Flemish Islands*.

The capital of the Azores is *Angra*, in Terceira, the residence of the civil governor, but the general residence of the bishop is in the Island of St. Michael.

The climate is delightful; the air generally clear and serene; the soil so prolific, that both European and tropical plants arrive at the greatest perfection: the face of the earth is, however, so diversified, as in some places to exhibit, within a small, extent, volcanic hills and productions, gardens of aromatic plants, pastures, vineyards, orangeries, &c. The greatest inconvenience of these isles is, their having been subject to eruptions and earthquakes; and, in some parts, where the coasts are low, the sea has, at times, overflowed the land, and occasioned considerable mischief. Yet, in the cultivated parts, the lava, once a stream of fire, is planted with oranges, lemons, and vines; and the land, formed from the decomposition of volcanic substances, is sown with Indian corn, small beans, and wheat. The islands still abound in waste lands, fit for the cultivation of flax, the vine, &c. Cereals and oranges have been the chief articles of export since the vines were destroyed by disease in 1853.

Being generally mountainous, they may be described from a considerable distance, and form a most valuable mark for vessels in erroneous reckonings, as no outlying dangers exist to impede an approach. The peak on the Isle of Pico, noticed hereafter, may be seen more than 20 leagues off.

It cannot be doubted that this archipelago must be considered as an immense ridge, on which craters are thrown up so as to form islands. The Island of St. Mary, the only one not situated in the general direction of the others, is not volcanic; no part of its surface appears to have suffered from heat or eruption subsequent to its formation. The Island of Pico is elongated from S.E. to N.W. in the same manner as all the other islands, St. George, St. Michael, and Terceira; and Flores and Corvo lie exactly in the same direction. Fayal appears to be nothing more than a part of Pico, for the general direction of these islands and their shores perfectly corresponds; and St. Michael's and Terceira appear to be connected by an intermediate range of volcanic formations, as will be subsequently seen. Few places offer such a variety of volcanic phenomena as St. Michael's; and the history of the eruptions and earthquakes on and near it give ample proof of the violence of the subterraneous forces over which it lies. In the descriptions of the separate islands will be found notices of the principal volcanic phenomena that have been recorded. The reader is directed, for a more complete description of the volcanoes, &c., of the Azores, to an article in the "Nautical Magazine" for 1841, page 752, consisting of extracts from the "Philosophical Transactions," and "Von Buch's Descripcion Phisique" of these islands.

The population of the Archipelago from the census of 1857 amounts to 241,646.

Winds at the Azores.—In the former part of this work, in the section treating on the subject, we have given descriptions of the general phenomena of the winds and hurricanes of the Atlantic, and the laws by which they appear to be governed, as deduced from the numerous and careful observations that have been made at various times. In connexion with that system of aerial currents, and their perturbations, we have reserved the consideration of that part of the subject which is connected with the Azores, and their vicinity. It will not be necessary to recapitulate any of the principles or statements which have been before given, for which the reader must refer to that division of the subject, as detailed in page 228 and following, and in pages 466-7.

Similar hurricanes to those described in the section devoted to the subject seem to be prevalent at the Azores, and in some measure to be governed by the same laws. This it will be very important for the mariner to know, and therefore the following observations, by T. C. Hunt, Esq., the British consul at St. Michael's, will be interesting:—

"The regularity with which gales enter these seas in the N.W. quarter, and, after crossing them, disappear at the S.E., is a circumstance the knowledge of which may be highly serviceable to the commanders of ships sailing across the Atlantic.

"The centre of a gale, on its approach, always effects a descent in the barometer, and a change in fall of rain. In its actual passage over the instrument, the descent generally reaches 28·50, from which a rise of one-

tenth appears to take place for every 10 miles' removal of the centre; so that the number of miles distance from the centre of an approaching gale might, perhaps, be indicated by the number of hundredths shown by the barometer over the extreme of 28·50.

"The difference in the *fall of rain** has also its regularity, the approach of the centre bringing a temporary increase, and then a cessation of the rain, which is renewed, and, in a reversed order, diminished on the removal of the centre. According to the observations made at this office, there appears to be in every gale of wind a zone of rain about 120 miles in breadth, heaviest on the inner edge, which is about 60 miles distant from the centre; that the fall of rain decreases in proportion to the distance from this line; and that the fall on the inner edge, being about twelve-hundredths of an inch per hour, the decrease is about one-hundredth for every 10 miles of removal.

"In order to follow out the views of Colonel (Sir W.) Reid, the British consul and the vice-consuls at the Azores kept regular daily tables of the direction and force of winds, between May, 1840, and Nov., 1841; and the courses of twenty gales which occurred were compiled from them, and the details of them are given in the 'Nautical Magazine,' as before quoted."

From the particulars of these twenty gales, of which the courses have been accurately observed during the years 1840-1,† there appear to be some general conclusions which may be deduced. The first circumstance developed by the inquiry is, the general direction of storms passing across the Azores. The coincidence of this course with the Great Atlantic Current, which is a continuation of the Gulf Stream, which may every day be traced to the neighbourhood of the Azores, and which the sudden rise of water in those islands (where, having been hastened by a gale, it is suddenly checked in any locality by the operation of the wind, accompanied by a diminution of atmospheric pressure) proves to be sensibly carried beyond them, goes very far to identify the Azorean streams with the tropical gales and hurricanes traced in the able work of Colonel Reid, from the South American coast, along the course of the Gulf Stream to Cape Hatteras, in North America. There is a further resemblance in their diameters. In the chart which Colonel Reid has composed of the great hurricane of October the 10th, 1780, the diameter given to it, in the latitude of the Azores, is about 550 miles. Of the Azorean gales under consideration, four were about this diameter, eleven of about or under 650, and five under 900.

With respect to navigators, for whose benefit these inquiries are chiefly intended, the use which may be made of this knowledge of the courses, taken by storms across the Azores, is in the direction of vessels which may be reached by them. It seems probable that if a ship were met by a violent gale near the Azores, her best course would be to steer, so far as the veering

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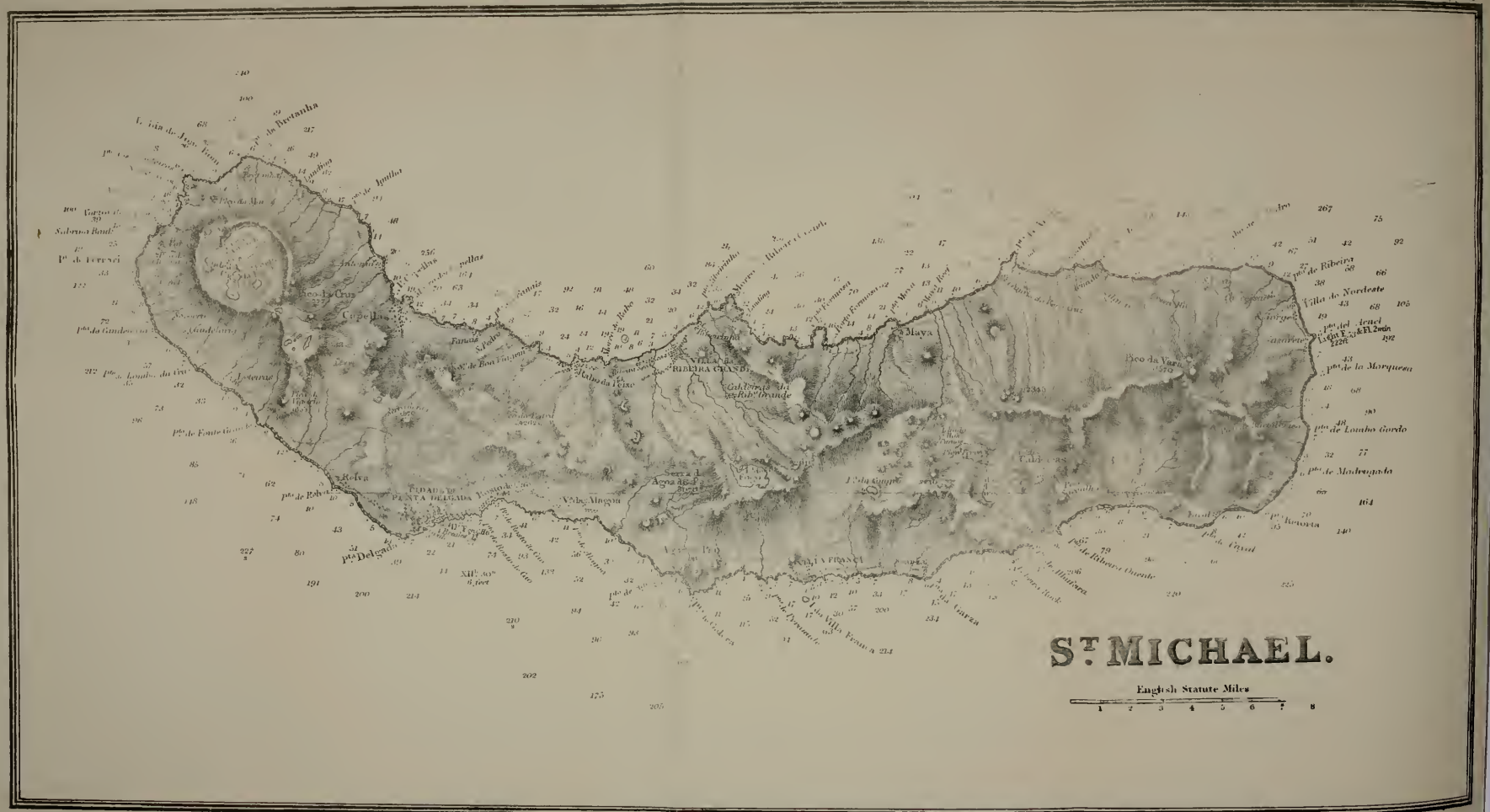
* In the Azores a southerly wind creates great humidity in the atmoshere; a northerly wind removes it. Under the former influence, there is frequently two per cent of water in the air, under the latter, less than one.

† The commencement of these gales was on the following days, viz.:—1840, June 4th, Aug. 19th, Oct. 3rd, Oct. 7th, Oct. 9th, Nov. 2nd, Nov. 11th, Nov. 14th, Nov. 28th, Dec. 1st, Dec. 6th, Dec. 11th, Dec. 15th, Dec. 27th; 1841, Jan. 11th, Feb. 3rd, Feb. 11th, March 6th, March 19th, Sept. 8th, and Sept. 18th.


St. MICHAEL.
English Statute Miles
1 2 3 4 5 6 7 8
Ponta Delgada
Villa da Ribeira Grande
Villa Franca
Agoa de Pau
Serra
Maya
Pico da Vara
Pico da Cruz
Capella
Relva
Arieiro
Fanaes
Fenaes
Ribeira Grande
Ribeira Quente
Ribeira Secca
Ribeira Seca
Ribeira Grande
Villa do Nordeste
Pico de Ribeira
Pico de la Marqueza
Pico de Lomba Gorda
Pico de Madrugada
Pico de Ribeira Quente
Pico del Arieiro
Pico de Bretanha
Pico de Bretanha
Pico de Bretanha

of the wind would allow, due North or South; that if she steered to the eastward, she would accompany the gale, and be overtaken by the greater violence of its centre, and that by steering to the West she would sooner meet the centre, or run into a new gale.

Whatever may be the cause of the occasional deflection of the Azorean storms, whether it arises from collision with another storm, or from atmospheric gravitation (the radiation of heat from the islands being always very great), the uniform effect appears to be a diminution of their progressive velocity, and frequently an increase of their rotatory force.

But as far as these effects can be foreseen, from a knowledge of the deflection (presuming it always to be accompanied by a slower progression), it is worthy of observation, that the deflection never appears to take a turn to the northward, but always to the South. If this be true, the safest course for a ship in these gales is to the North, unless there are very cogent reasons for a departure from this supposed rule.

The following Table shows the mean duration in days, of the winds from each quarter, from the results of ten years' observations made by Thomas Carew Hunt, Esq., between January 1, 1840, and December 31, 1849:—

Winds.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Summer. ½ Year.	Winter. ½ Year.	Whole Year.
N. ..	1·32	1·12	1·18	1·27	1·52	0·15	2·11	0·14	1·40	2·15	2·78	3·52	7·29	11·07	18·36
N.E. .	7·64	6·13	6·73	8·89	10·9	10·1	13·7	15·1	11·6	10·9	6·84	7·71	69·04	46·0	115·04
E. ..	1·07	0·53	0·66	1·80	1·28	0·76	1·17	0·30	1·20	0·62	0·59	1·72	6·51	5·19	11·70
S.E. ..	4·42	3·90	8·03	2·44	2·44	3·13	2·73	4·71	4·94	4·45	3·74	3·60	20·98	23·17	44·15
S.	2·88	0·95	2·25	0·79	0·95	0·67	0·11	0·08	0·12	1·51	1·54	2·0	2·72	11·13	13·35
S.W. .	6·46	6·60	9·01	4·08	3·73	4·43	1·63	2·80	3·44	4·13	6·94	5·32	23·20	38·46	61·66
W. ..	1·16	1·17	1·58	1·51	2·38	1·51	2·09	1·73	1·01	1·35	1·39	1·52	10·23	8·17	18·40
N.W. .	5·80	7·04	5·44	8·06	8·09	8·29	4·82	4·73	5·53	5·19	6·08	6·53	39·52	37·11	76·63
Calm .	0·19	0·5[illegible]	0·12	0·57	0·50	0·24	0·17	1·29	0·74	0·65	0·10	0·08	3·51	1·70	5·21
Surf on Shore.	1·1[illegible]		6·49	2·70	1·15	0·5[illegible]	6·03	0·20	2·07	4·42	6·42	7·38	6·65	38·85	45·50

ST. MICHAEL'S.—The Island of St. Michael consists of a number of mountains, hills, and declivities, which are evidently the production of volcanic eruptions. The mountains and hills clearly indicate, by their conical figure, and the cavity at their summits, their being the production of fire, and bear unequivocal marks of the effects of this destructive agent, in an accumulation of lava, scoriæ, and volcanic sand.

Externally, the volcanoes appear extinguished, but they are supposed still

to burn internally and invisibly. Of this, *Caldeiras*, or fountains of boiling water, in the Valley of Furnas and other parts are evident symptoms. There have existed three principal craters, whose vertices now form three great lakes, situate towards the centre and the northern and southern portions of the island. From those craters vast mountains have been thrown up; and, in proportion as these ceased to vomit forth matter, partial eruptions burst out, and formed the lateral hills and declivities, which extend themselvis in every direction from the mountains surrounding the lakes. The cessation of fire from the different craters has been attributed to water, which appears to have gained access to each, and suddenly extinguished the effervescence of its mineral contents; and the fire now seems confined to stations, where it operates only in boiling the water with various degrees of activity and force.

The island, in fact, seems to be of such a structure and conformation, that the water passes freely throughout its volcanic caverns, and is easily forced out without shaking or disturbing the earth. Of these extinguished craters, that (the *Sette Cidades*) in the N.W. part of the island is the largest, and is about 3½ miles long by 2 miles broad. The interior is occupied by two lakes, and the ridge bounding it is nearly of equal height throughout, except where it rises into peaks, and on the N.W. presents a gap between two hills, 1,620 and 1,770 ft. high. The second crater is about 3,060 feet high, and is called the *Agoa de Pao;* it is in the middle of the island, and situated in a large mass of pumice stones. *Agoa das Furnas* is the third crater, 995 ft. high, and in it are the hot water springs, but it is not so high as that of *Alagoa Grande.* From Agoa das Furnas the mountains of pumice-stone continue higher, forming a continual range as far as *Pico de Vara*, the highest of which is 3,560 ft. above the sea, and is the only summit on the island where snow is found.

After Gonzalo Velho Cabral had succeeded in establishing a colony in the Island of St. Mary, discovered in 1431, he landed on the N.W. coast of St. Michael, in 1444, and the extensive plains he saw appeared to him to be so capable of being highly cultivated that he returned immediately to St. Mary to make preparations for colonizing his newly-discovered country. But when he went there the following year, with everything necessary for the establishment of his colony, what was his surprise when in the place of the plains he found an enormous mountain, which had been elevated on them, with an immense crater. This mountain is called the *Alagoa de los Sette Cidades*, on which are the two lakes *Logoa Grand* and *Lago Azul*, as mentioned before. After the elevation of this great mountain, the island remained tranquil until 1522, when an eruption overturned the two hills *Sorical* and *Rubical*, and entirely destroyed the town of Villa Franca, and 4,000 inhabitants also lost their lives. In 1563, an eruption occurred of the *Pico Sapadeiro*, and a large current of lava ran into the sea on the North side. In 1591, seven shocks of earthquakes occurred, and Villa Franca was again destroyed. In 1638, the island to the West was found as described elsewhere. In 1652, some hills near Ponta del Gada threw up an immense quantity of stones and cinders, spreading destruction around. In 1691, after some very violent earthquakes, several small islets appeared not far from the coast. In November, 1707, a torrent, attributed to the breaking of a

waterspout, fell on Ponta del Gada, and caused great damage. In 1719, a new island appeared in the West, also mentioned hereafter. In 1720, a succession of violent earthquakes injured the towns and villages, and shook down great rocks from the cliffs, &c. In 1744, October 5, another fall of water occurred, washing down the valleys of Povoaçao and Fayal de Leira, carrying away great parts of two villages. The cause of these floods, still occurring remains unexplained. The great Lisbon earthquake in 1754 was also felt here, but there was no eruption. In 1806, a mass of rock slipped from the valley of the Furnas, leaving a chasm 100 yards in diameter; and in 1811 a similar fall occurred close to the same place. The eruptions of August 11, 1810, and of Sabrina Island, June 13, 1811, are described below. In 1838, another landslip occurred at the Furnas. In 1839, December 5, a rise of the sea, like that in 1755, washed down several houses, &c., on the South coast. The last earthquake which was felt here was that which devastated Terceira, in June, 1841, of which a description is given in the notice of that island.

The circumstances attending the formation of Sabrina Island are described as follows (the island had previously been apparently quiescent):*—In the early part of the year 1811, a most awful and tremendous explosion of smoke and flame issued from the sea at the distance of half a league from the shore at the western end of the island. From the depth of about 40 fathoms, in the ocean, issued smoke, fire cinders, ashes, and stones of an immense size. Innumerable quantities of fish, some nearly roasted, and others as if broiled, floated on the surface of the sea toward the shore. Thus a dangerous shoal gradually formed.† On the 10th of June, the crew of the *Sabrina*, British sloop of war, observed two columns of white smoke arising from the sea, which they supposed to arise from an engagement, and made sail toward it, but were disappointed by the wind dying away. The smoke continued to ascend, with volumes of flame, and they then concluded it was a volcano. Next day they were close in with the land of St. Michael, and found the volcano still raging. They learned on the island that smoke was first observed on the 13th of June; two or three days previous to which there had been felt repeated shocks of earthquake in the capital of St. Michael, which threw down several cottages and portions of the cliff toward the N.W., so that destruction was feared on the island; but these ceased as

* The approximation to an eruption has, however, at times appeared to have been very close. On the 11th of August, 1810, at the hour of ten p.m., slight shocks of an earthquake were felt, which continued, at intervals of a few minutes, for four hours. Between two and three o'clock next morning, a dreadful rocking was experienced throughout the whole island; several houses, unable to resist its violence, were thrown down, and many others were greatly damaged; and such persons as sought safety in the open air were dashed to the ground. On the eastern side of the island an orifice was discovered, resembling the crater of a volcano, and out of which flames occasionally burst forth; but they do not appear to have been accompanied by any ejection of volcanic matter.

† The flames were first seen the night of the 1st of February, but invisible indications of its operations had been felt in shocks on the island, from the middle of the preceding year. Its observed situation was S.W. of Point Ferraria, and due West fram the Pico de Ginetes, at about 1½ mile from the nearest shore. The brig *Swift*, with all her crew, were lost on this spot, before the existence of the shoal was known.

soon as the volcano broke out. On the 18th, the *Sabrina* went as near to the volcano as she could with safety, and found it still raging with unabated violence, throwing up, from under the water, large stones, cinders, ashes, &o , accompanied with several severe concussions. About noon on the same day they observed the mouth of the crater just showing itself above the surface of the sea, were there were formerly 40 fathoms of water. At three p.m., same day, it was about 30 feet above the surface of the water, and about a furlong in length. On the 19th they were within 5 or 6 miles of the volcano, and found it about 50 feet in height, and two-thirds of a mile in length, still raging as before, and throwing up large quantities of stones, some of which fell a mile distant from the volcano. The smoke drew up several waterspouts, which, spreading in the air, fell in heavy rain, accompanied with vast quantities of fine black sand, that completely covered the *Sabrina's* decks, at the distance of 3 or 4 miles. On the 30th they proceeded on a cruise, leaving the volcano about 150 feet high, and still raging as formerly, and continuing to increase in size. On the 4th of July they again visited it, and found that a complete island was formed, and perfectly quiet. The captain and several officers landed upon it, and found it very steep, and its height from 200 to 300 ft. It was with difficulty they were able to reach the top.

On the 17th of June, Captain Tillard, of the *Sabrina*, accompanied by Mr. Reid, the British consul, with two other gentlemen, proceeded overland to the cliff nearest to the volcano, and which was between 300 and 400 feet above the level of the sea. The first appearance it presented was that of an immense body of smoke revolving in the water almost horizontally, in varied involutions; when suddenly would shoot up a column of the blackest cinders, ashes, and stones, in form like a spire, and rising to windward at an angle of from 10° to 20° from a perpendicular line. This was rapidly succeeded by a second, third, and fourth, each having great velocity, and overtopping the preceding one till they had attained an altitude as much above the level of the eye on the cliff as the sea was below it. These bursts were accompanied by explosions of the most vivid lightning, with the noise like the continual firing of cannon and musketry intermixed; and, as the cloud of smoke rolled off to leeward, it drew up the waterspouts, above mentioned, which formed a beautiful and striking addition to the scene.

Subsequently the islet fell by degrees into the sea; and, in the middle of October, no part was left above water; but a dangerous shoal remained in the place which it had occupied. In February, 1812, smoke was discovered still issuing out of the sea near the spot.* In June, 1841, Captain Vidal, in H.M.S. *Styx*, anchored in 16 fathoms, on the site of Sabrina Island, and found that the least water thereon was 15 fathoms.

St. Michael's contains one city, five principal towns, fifty-four parishes, and about in 1840, 39,098 males and 41,711 females—total 80,809, living in 19,726 houses.

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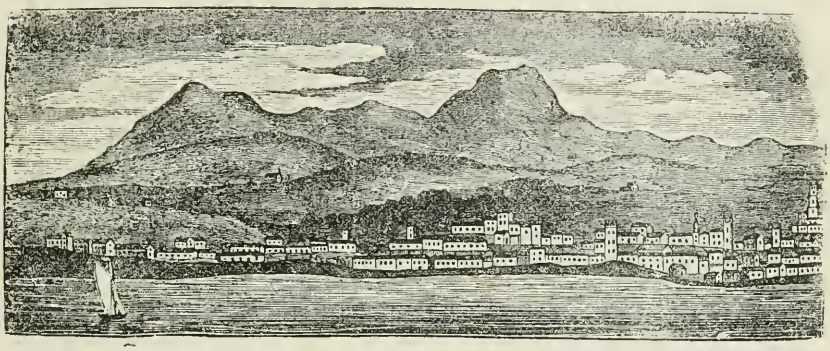
* About 15 leagues to the westward, a volcano, which had appeared in 1638, broke out from the sea in 1719, and disappeared in 1723. A depth of 80 fathoms was afterwards found on the spot which it had occupied. But see the description of Terceira for thi volcanci shoal.

The coast is very bold, and may be approached without fear in almost every part, the N.W. side excepted. Its military strength consists of 300 or 400 troops, with a militia of several thousand peasantry. The principal fortification is the castle of St. Bras, which is close to the sea, and the western end of the city of Ponta Delgada.* The island has many strong local holds; and several of the hills and passes, if judiciously fortified, would be impregnable.

The chief trade of St. Michael's consists in the export of oranges to English ports; of these, in the year 1876, in British vessels, £123,000 worth, and in Portuguese vessels, £13,500 worth was exported. In addition to these, tangerines, bananas, and pine-apples were largely exported, also cereals. Of the 342 vessels visiting St. Michael in 1876, 133 were British, 14 American, 4 Brasilian, 1 Dutch, 2 French, 1 German, 186 Portuguese, and 1 Spanish.



Outline of the land over Ponta Delgada.

The Road of Ponta Delgada, off the principal city, has good holding ground, on which ships may ride safely, excepting during gales from W.N.W. to S.S.E. Should a vessel be forced to quit the anchorage in winter, by a southerly gale, it will be best to round the western end of the island, and await a shift of wind from the N.W., which commonly succeeds a S.W. wind. Thus may the roadstead be easily regained; but, by running to the south-eastward, it may be ten days, or more, before you can beat back to the road. In beating up, keep close in-shore, only avoiding some rocks, which lie near Ponta del Galera. Fresh water is easily procured in the craft of the island.

The City of Ponta Delgada is the chief seat of commerce, and contains full 20,000 inhabitants. This town appears exceedingly pleasant from the offing. At *Fouras*, 18 miles inland, are the hot springs of mineral water, where baths have been constructed, and are much resorted to by invalids.

Lights.—The light-tower, completed in August, 1878, is 26 ft. high, and situated about 200 yards within the extremity of the breakwater in progress. The light is a fixed *red* light of the fourth order, elevated 47 ft. above the sea, and should be visible in clear weather from a distance of 9 miles. The

* The Hospital of Mercy at St. Michael's, thanks to the liberality and kindness of some of the merchants, now admits British seamen patients, where they are well treated.

soundings, in an easterly direction from low water at the extremity of the breakwater, increase regularly to the depth of 12 fathoms. A small fixed *bright light* is also shown on the Custom-house.

Signals.—In 1869 it was announced that the following signals had been established: From vessels to the shore.—1. *Want a pilot*—national flag on the foretopmast, and pennant underneath. 2. *Am damaged*—pennant on the foretopmast, and national flag underneath. 3. *Have no anchors*—national flag aft, pennant underneath. 4. *Am very leaky*—pennant aft, national flag underneath.

From the shore to sea.—5. Look out for a good place to receive a pilot—*red flag, a streamer below.* 6. Pilot cannot be sent on board—*a streamer, and red flag below.* 7. Put out to sea with the least delay—*national flag, and the red one below.* 8. Can come into the harbour—*red flag.* 9. General prohibition to enter the artificial harbour—*black ball, and red flag below.*

The Breakwater has been making slow progress during many years, and at one time threatened to be rather detrimental than advantageous to the shipping frequenting the roadstead of Ponta Delgada, on account of its so frequently being washed away and strewing the anchoring ground with the stones of which it was constructed. Mr. Consul Read, writing in May, 1874, remarks:—"The breakwater forming the artificial harbour of Ponta Delgada has attained an extent of 580 metres (about 630 yards), the projected length being 860 metres at low water mark. The portion already constructed does not yet present the form definitely adopted, namely, that of the breakwater at Holyhead, but has an appearance of solidity, considering its great breadth at low water, and the almost complete state of the slopes under low water mark, which are a guarantee of its resistance against the violence of the sea, and consequently of the shelter afforded to vessels during the time required for advancing it to the desired form. To effect this object, and to construct the remaining 280 metres of the breakwater, it is considered that ten years will be required in order that the work may be carried out with security, and that the annual grant, amounting to about £18,000, may not be exceeded.

"The part of the artificial harbour already sheltered has an area of about 25,000 square metres, with a depth varying from 10 to 30 ft. below low water mark; from forty to fifty vessels, moored in six tiers, can find shelter in this part, including steamers of 500 to 700 tons. No less than seven steamers of considerable tonnage, and twenty-eight vessels of various sizes, having remained in perfect security on the 6th of February of this year during a heavy gale from the S.E., the quarter to which the harbour at present is most exposed. Vessels drawing 20 ft. can enter this part of the harbour.

"The part of the artificial harbour corresponding to the portion of the breakwater still to be completed will present an area of more than 90,000 square metres, with a depth varying from 30 to 60 ft., and admitting about 100 vessels of all sizes. Thus, when completed, the harbour will afford shelter to about 145 vessels, including a fair proportion of vessels of large tonnage, even trans-atlantic mail steamers and ships of war.

"A quay was also commenced last year, alongside of which vessels drawing 18 ft. will be able to discharge. I am informed its length will be 50 metres.

"In the foundry which forms part of the breakwater works, important repairs to machinery, &c., of vessels can be effected with efficiency, the S.S. *Sidonian*, of the Anchor Line, not long ago having put into the port to have her screw-shaft repaired, and the manner in which the work was executed obtained the highest praise from the captain and chief engineer."

In March, 1877, the breakwater had not been increased in length, but some pile-work was in progress at the sea-end of the work. A new market is opened near the port.

The *Floating Dock*, completed in 1875, at a cost of £11,000, has been used by a steamer of 1,000 tons.

The artificial harbour, formed by excavating the square of St. Francis, and cutting a canal between it and the mole, was opened on March 1, 1870. The dues were fixed as follows:—From the 1st of April to the 30th of September, 10 reis for each cubic metre on vessels of less tonnage than 60 metres, and 30 reis on those exceeding that figure; and from the 1st of October to the 31st of March, 20 reis per cubic metre on the smaller vessels.

The next place of consequence to Ponta Delgada is that called *Ribeira Grande*, on the North side of the island; but there is no anchorage; and, having no harbour, it is dependent for its commercial supplies on the towns on the South side. *Villa Franca*, which is on the latter, has a very inferior anchorage, and that for small vessels only.

St. Michael, bold all round, may be approached without fear, as there are no rocks or dangers more than a furlong from the shore, excepting some rocks at the N.W. end, and the volcanic shoal, already described. The former extends about half a mile from the Bay of Mosteiros, near the north-western point. The winds most prevalent from October to April, are from S.W. to N.W., which frequently come in heavy squalls, particularly from the northward. In approaching from the eastward, Ponta de Galera, the southernmost point, should have a good offing, as the high land above it often occasions a calm, and there are some rocks off the point.

On approaching the N.W. end of the island from the westward, the appearance is very unpromising, as it presents barren mountains of stupendous bulk, with a coast like many ramified pillars of basalt, exhibiting, at top, a few trees of stunted growth. The impression made by a scene of rough and craggy cliffs, is, however, soon dissipated by a pleasing contrast on the southern coast, as this presents a beautiful acclivity, adorned by luxuriant vegetation. Open pastures, bounded by woods, vineyards, and corn-fields, interspersed with orange and lemon trees, everywhere meet the eye, and afford a landscape, extensive and various, that will always, in clear weather, be seen with delight.

Those coming in on the northern side of the island must be cautious of not getting embayed near Ribeira Grande, as there is no good anchorage on that side in case of a shift of wind.

The Road of Villa Franca is sheltered by the *Porto do Ilheo*, a remarkable volcanic rock, having a circular basin in its centre, with an entrance to it on the N.E., fronting the town of Villa Franca. The entrance of this basin has 7 ft. of water, and is just broad enough to admit a small vessel. The basin is about 100 fathoms in breadth, and has had a depth of from

to 18 ft.; the bottom of sand and small stones. This place is resorted to by small vessels for the purpose of careening, &c. It affords shelter from gales between West and South; but as a part of the S.E. side is low, the wind from that direction throws a heavy swell into it, and renders it dangerous; and vessels caught by this wind must be scuttled, as the only way to save them. Not more than four vessels can lie with safety on the outside, in winter, under shelter of the rock on the N.E., where there are 4 and 5 fathoms of water. The ground near the town is foul and dangerous; but it is stated that a ship may lie in 8 or 9 fathoms, between the town and islet, by fastening a hawser on shore.*

The *Porto do Ilheo* is a great natural curiosity; it having been originally a volcano of great height, whose apex has fallen into the caverns beneath, and forms the basin. Its appearance is extremely rugged and irregular. On its South side is a remarkable detached rock, distinguished by the name of the *Pyramid.*†

Of *Villa Franca*, Tofiño says:—"It is situated on a beach, which forms but a very small bight. The channel between the islet (*Ilheo*) and coast is of the width of 3 cables' lengths, or thereabout, and is its principal anchorage; it has 10 and 11 fathoms of water, sandy bottom, and vessels moor North and South, with a hawser on shore, on the islet; but the latter, owing to its diminutive size, does not shelter a vessel from the sea wind, between E.S.E. by South to S.S.W. The town is capacious, and water, with all kinds of provisions, may be had here."

The breakers seen to the N.E. of St. Michael's will be found described in the next section.

Don Vincente Tofiño, in his description of St. Michael's, states that *Point Ferraria*, the westernmost point of the island, is high and sloped, but a low point projects from it into the sea, so as to form a rocky ridge to the S.W. At the distance of a league from land this ridge has over it from 7 to 10 fathoms of water, and a heavy sea rises over it, very high.‡ The little harbour of *Mosteiros*, to the N.E., serves for boats only. Of the islets here, the largest is high, sloped, and smooth at its summit, with an aperture, through which the sea passes from one side to the other.

North Side of the Island.—Between the Ponta dos Mosteiros and Ponta da Bretanha the land of the coast is high and rocky, and it forms the *Bay*

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* There is a rock and reef (the *Lobeira Rock*) lying S.W. by S., three-fourths of a mile off Point Albufeira (which is 4½ miles East of Villa Franca). It is not volcanic, but has always been known. It is not on the early charts.

† In a letter to the editor, dated 28th of May, 1828, Captain Livingston says;—"The *Ilheo* seems to be filling up with sand. The most of the rock is a kind of conglomerate of lava, in detached pieces, sand, debris, and pumice-stone, and on the East side it seems gradually wearing away. The highest part appears about 80 feet high. There are cultivated terraces on it, with cane reeds, planted for shelter, and they grow not only potatoes and maize on it, but there are even a few poor vines, and some fine heath 3 to 4 feet in height.

"The singular volcanic *Peak of Camarinhas*, on the West end of the island, was the last active volcano in St. Michael's."

‡ There is a similar ridge, with islets on it, extending about a league from Point Matogos, the N.W. point of the island; it has from 2 to 6 and 7 fathoms over it.

of *Joao Bom;* at the bottom of which appears a very sharp-pointed mountain, called the *Pico de Maffa*, which serves as a very useful mark for ascertaining the coast.

Within the Ponta do Bretanha, and extending eastward, is the long village of Bretanha. The country here is highly cultivated, and pasture land.

The *Villa de Ribeira Grande*, already noticed, is rich, stored with all kinds of provisions, abounds with good water, but landing is practicable only when the sea is very smooth.

PORT CAPELLAS.—The following description of this small harbour on the North side of St. Michael's is by Mr. Hunt, the British Consul:—"Persons having stated that the bottom of the North side of St. Michael is foul in the anchoring depths, and that no vessel would be likely to recover her anchor if she brought up there, I thought it my duty to take the earliest opportunity of proceeding thither, with the agent for Lloyd's at this port, for the purpose of ascertaining the truth of these assertions.

"The result of our survey was, that at about half a mile distant from the shore, between Ribeira Grande and Capellas, there is a line, which, with occasional projections towards the land, separates the foul and stony bottom of the coast from a perfectly smooth and firm bed of fine sand, sloping to seaward; that, along this line, the depth varies from 25 to 35 fathoms; and that, from the rugged nature of the coast itself, the small port of Capellas is the only part at which it would be safe for boats to disembark." In a small plan, also by Mr. Hunt, the marks for anchoring are, first, the outer point of the port on with the Morro of Rio Grande, bearing E. by S.; and, second, *Point St. Antonio* on with *Point Minho.*

Arnel Point and Lighthouse.—The N.E. point of the island is *Ponta da Ribeira*; at $1\frac{3}{4}$ mile to the S. by W. $\frac{1}{4}$ W. (*S. by E.*) from this is the *Ponta del Arnel*, having a small port of the same name, but it is unsheltered, and the bottom rocky. The two points are of equal height, but between them is a slender bay, with sloped rocky land, in the middle of which is a very remarkable glen, wherein is a small river.

The lighthouse on Arnel Point is situated on the eastern side of the building, which serves as the keepers' dwelling. It is an octagonal tower, the base of which is 183 ft. above the sea. The light is a fixed *bright* light, varied by a *flash* every 2 minutes; elevated 222 ft. above the sea, and visible 18 miles off; the flashes 25 miles. Position, lat. 37° 49′ 20″ N., long. 25° 8′ 30″ W.

The distant view of St. Michael's is sometimes deceiving, in consequence of the haze which frequently covers the land; and the following observations will be useful in explaining any uncertainty which may be felt in making this island. Captain Midgley says:—"On the 26th of September, 1840, at daylight, I hauled up on a N.E. by E. course, by compass, to make St. Michael's, with a moderate S.S.E. breeze and fine clear weather. At noon saw the West end of the island bearing N.E. $\frac{1}{2}$ E., and although the weather was apparently clear in every other part, a small portion of the land could only be seen, the remainder being covered with clouds and haze. The above bearing and observed latitude placed the ship 31 miles from the West end of the island. At 3 p.m. saw the eastern extremity of the land distinctly,

but could not make out the land in the centre of the island; indeed, the haze which hung over it so completely deceived me for some time, that I considered *two* islands were in sight, and that I must have made some mistake in my observations; but, on drawing nearer to the land, as the sun approached the horizon, the fog dispersed, and I had a good sight of the centre of the island also. After sunset, the evening was fine, with serene clear weather. At 8 p.m. the light of Ponta Ferraria was seen at 10 miles off—but such a light! had it not been marked on the chart, I could not have believed it reflected from a lighthouse established for the direction of shipping—the light was really miserable; and, as it was not shown until long after every trace of daylight had disappeared (for the weather was quite clear, and a careful look-out kept for it), the light which was seen might have been reasonably supposed to be that of some fishermen or passing vessel. (It has since been stated that no lights are exhibited.)

"On December 31st, 1841, I intended to pass to the southward of St. Michael's, but a scant wind obliged me to bear up for the West end of that island, on passing which it again had the appearance of two separate islands, with well-defined extremities to each, the land in the centre being covered with fog and haze. When seen from the northward, on the following day, it had again the same appearance, that of two separate and apparently well-defined islands."

ISLE OF ST. MARY.—The preceding description of the appearance of St. Michael's will apply generally to St. Mary's and the other islands. The town is on the South side, toward the West, on a bay, in which there is an islet; and between this island and the land is the anchorage, with a depth of 6 and 5 fathoms.*

St. Mary's has a town and three villages, with about 4,500 inhabitants. Its chief productions are wheat and barley, of the first quality, with wine and cattle; but only sufficient for its own consumption. It has water in abundance, but of wood little, and a scanty proportion of fruit and vegetables.

"The Island of St. Mary is about 7 miles in its greatest, and 5 miles in its smallest diameter. It has nearly in the centre the double-peaked mountain of Pico Alto, 1,889 ft. in height, which falls on the East and West sides to a shelving base of about a mile in breadth, and 850 ft. above the sea. To the North and South it throws out a range of undulating heights, which terminate at the sea in lofty mural cliffs of more than 200 ft. elevation. The East side of this range is covered with hills, diminishing in altitude as they recede from the centre, and intersected by numerous gorges of increasing width and depth, the channels by which the heavy rains of winter reach their points of discharge. The West side is a slightly inclining and undulating plain, also cut by ravines, terminating in cliffs more than 100 ft. high. The aspect of St. Mary's is therefore on all sides perfectly bold; the central

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* Immense quantities of molluscæ, or sea-worms, are certain signs of the proximity of St. Mary's. Some of them are of a white colour, or of arrowroot mixed with hot water, and are about 18 inches long, with orange spots on them, like the eyes of a peacock's tail.—*A. Livingston.*

peak distinct; the subordinate range high and of varied outline; and the coast abrupt, precipitous, and based by the usual accompaniment of fallen masses.

"In its geology, St. Mary's is not like the other islands, where the surface of recent volcanic matter conceals whatever may have been their original constitution, or the progress of their growth. It is of trap formation, and contains in its beds of marine shells, proofs of its elevation from the sea, but there are some points of similarity in its structure to that of St. Michael's; this is also the case with respect to Madeira, and still more to Sicily."*

"On the 31st of December, 1841," says Captain Midgley, "at sunrise, with very clear weather, I made St. Mary's, bearing E.N.E. by compass, distant 45 miles, at which time the land appeared from the deck to be like two small well-defined paps, rising out of the water close together; but on a nearer approach on the same bearing it appeared like a saddle land, which appearance it retained until the summits of some of the lower hills became visible."

Ponta do Castello, the S.E. point, is high, and has a break, which forms a peak, in the shape of a sentry-box. A vessel may anchor with this point S.W. $\frac{3}{4}$ S. (*S. by W.*) and close to it in 10 fathoms, bottom of sand.

On the Eastern Coast, at $2\frac{1}{2}$ miles N.N.E. $\frac{1}{4}$ E. (*N. 2° W.*) from Pta. do Castello, is the *Ponta dos Cedros*, which is likewise high; between these is a small point, off which is a low rock, at 3 or 4 cables' lengths from the coast, called *Mulha Rock*, but between it and the coast is a clear passage of 12 fathoms, in mid-channel, at half-flood.

At N. $\frac{3}{4}$ W. (*N. W. by N.*) $4\frac{3}{4}$ miles from Pta. dos Cedros is *Ponta dos Matos*; between is the *Pta. de la Feiteira*, with the Islet and Port of *San Lourenzo*. The point is high and remarkable, when near the coast. The islet is likewise high, and, on the eastern side of it, has a cave, into which the sea enters, and where a boat may be sheltered.

San Lourenzo Port is formed by the Islet and Ponta dos Matos, which are a full mile distant from each other. The bottom is sandy, and between the points is a depth of 10 fathoms, increasing gradually outward, but the depth of anchorage should not be less than 20 fathoms. Water may be readily obtained here by making hollows, or small pits in the sand on the beach, where the least excavation produces water of the best quality. There are several houses and a church close to the beach.

The *Ponta das Lagoinhas* is the N.E. point of the island. The Islet Lagoinhas, which lies off this point, is high, and sloped like a mitre; and, on being seen, in an East or West direction, exhibits a small level point, extending a little way into the sea. A rock, lying between the islet and land, obstructs the passage to large vessels.

The *North side* of the island affords neither shelter nor anchorage; the whole of the western side is low and uniform.

The port and town are situated, as already noticed, on the S.W. side of

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* From a description of St. Mary's, by Mr. Consul C. Hunt, in the "Journal of the Royal Geographical Society," vol. xv., 1845, p. 260, *et seq.*

the island. The bottom here is sandy, and in some parts rocky, with from 10 to 4 fathoms of water. The rocky part is on the western side, and the eastern is the clearest. The *Ponta da Marbao* is the easternmost part of the bay, and this, with the next point to the eastward, *Malbusca*, form a larger bay, divided into two parts by a black point, *Pedrera*. The coast hither, from Point Marbao, is the most regular, and is called *Figueral;* on the top of it is a remarkable rugged mountain, but it is not so high as those on the North side of the island. Ponta de Malbusca is high, and stands at a distance of 2 miles to the westward of Ponta da Castello, the S.E. point of the island.

The *Road of St. Mary* is open, and exposed to southern gales. On this account it is resorted to, in summer, by small vessels only. In order to be ready for a start, it is proper to anchor to the S.E. of Marbao Point, opposite Figueral, already described. The best anchorage known to the pilots is about a mile from the coast, in a line with Malbusca Point, and with the castle at the S.W. part of the town of St. Mary entirely open of Marbao Point. Here is a depth of 36 fathoms, bottom of sand; but, at a short distance eastward, the ground is foul. Hence it is that Port San Lourenzo, on the N.E. side, is considered as the best anchorage about the island. At either place refreshments may be obtained, as at the other islands, with the addition of partridges, which abound here.

THE FORMIGAS BANK AND ROCKS lie N.E., *true*, from the N.E., and nearest, point of Santa Maria, 19¾ miles distant.* It is formed by a submarine mountain of very irregular elevation, and which, traced to the depth of 200 fathoms, was found to extend 6½ miles N.W. to S.E., by about 3 miles in greatest breadth.

Near its western margin there is a narrow cluster of black rocks, known as the Formigas (or *Ants*), which are about 800 yards in length by 150 in extreme breadth, their relative direction being N. 25° E. and S. 25° W., or *North* and *South, true*. The southernmost of them, for about 350 yards, forms rather a closely connected mass, having a small bay on the West. The northern ones are more separated from each other, and all are of comparatively little elevation, but the profile exhibits a few hummocks. That on the southern extremity, which is 27 feet above low water springs, is in lat. 37° 16′ 14″ N., long. 24° 47′ 6″ W.

The most elevated rock of the group, named *Hormigon*, by Tofiño, is 35 ft. in height, and stands on the eastern side, about 200 yards from the northern-

* Captain A. T. E. Vidal, who has surveyed these islands, says, with respect to Tofino's representations of the Formigas;—"It is with regret and vexation I have to state that I find Tofino considerably in error in that celebrated hydrographer's work, relative to this locality. The true bearings of Punta Castello, as ascertained by Capt. Vidal, differ from those of Tofino 4° 34′ more westerly, and Pico Alto 6° 18′ more westerly. This difference in bearing is on a distance of 22 miles. Although my observations on board the vessel with sextants perfectly confirmed the true bearing obtained with the theodolite, I was unwilling to think Tofino to be in error. I therefore landed again the next afternoon a little later, to have a lower altitude, and that second day's result was Punta Castello S. 29° 2′ W., and Pico Alto S. 40° 36′ W.; Tofino or his people are therefore in error. This correction will place the danger about 3′ of longitude to the eastward of its assumed position, and in the same latitude.

most rock, and somewhat more isolated than the others, and having an inclination to the southward.

With smooth water there is no difficuly in landing, particularly on the southern rocks; but in strong winds or a high swell the sea rolls over them all, leaving a black naked surface entirely devoid of vegetation. At 130 yards South of the southern Formiga is another small rocky shoal patch, visible at low water, the channel between having 5 to 15 fathoms. Again, 600 yards South of the South Formiga is another small rocky patch, having 4½ fathoms on it at low water. It is steep-to on all sides but the North, where it is connected with the rest by irregular depths of 8 to 14 fathoms.

On the North the Formigas may be approached within a few yards, but a narrow ridge runs out 400 yards with varying depths, but no danger. It has 18 fathoms on its outer end, and immediately drops into 30 and 50 fathoms. On the East and West the Formigas are quite clear, with deep water close up to them; on the West the bank extends half a mile, but all very deep water.*

Tofiño thus describes them:—"The Formigas are some rocks which navigators have considered as extremely dangerous, imagining a great part of the space hereabout to be strewed with sunken rocks, and therefore to be avoided; but, having examined these dangers, it is proved that the whole of them are visible, concentrated and clear, and that vessels of any burthen may steer for them, in order to pass on the North and South side, as may be most convenient.

Other rocks also exist, as shown in the next paragraph, at the distance from them of about 3½ miles to the south-eastward. We derive our knowledge of the latter through the favour of Capt. Livingston.

Dollabarrats' Shoal.—To the S.S.E. of the Formiga there is a danger, which was shown on a chart of the Atlantic Ocean, 1766, but afterward omitted in other charts, from want of positive information as to its existence. This shoal was seen by P. Dollabarats, commander of the ship *La Marie de Seboure*, in 1788, on his return from Martinique to Bayonne. On the 7th of March, at 3 p.m., when about to double the Formigas, at the distance of three-quarters of a league, he descried a breaker to the S.E. of his ship, which appeared to extend a league *true North and South*. He observed that it lies *S.E.* 5° *S.* (*true*), at the distance of 1½ league from the Formigas.

A new and very beautiful brig, the *Zillah*, Martin, of Dundee, bound to Hayti, struck on a sunken rock "off the Formigas," at 10 o'clock in the night of the 9th of April, 1832, and was abandoned at 3 p.m. of the next day, having then 7 ft. of water in the hold. About midnight she was seen to go down. Crew picked up and saved by the *Morley*, of London.

Capt. J. D. Markland, of H.M.S. *Briton*, in a letter dated 20th February, 1832, writes:—"I hove-to for the night between St. Michael's and St. Mary's, being anxious to see the Formigas Rocks; and soon after daylight, with a thick morning, we fell in with a dangerous shoal breaking heavily, and as the fog cleared away we saw the Formigas. When the rocks and

* Account of the Formigas Bank, by Capt. Alex. Vidal, R.N., Journal of the Royal Geographical Society, vol. xix., 1848, p. 160.

the shoal were in one, the shoal bore from the rocks S.S.E. about 3 miles. This must be the *Dollabarats' Shoal.* The Formigas are properly placed."

In confirmation of this statement, the following appeared in the *Shipping Gazette. Notice to Mariners.*—Lisbon, Dec. 6th, 1843. A notice has been issued by the Minister of Marine, to the effect that a shoal, with 11½ ft. of water on it, has been discovered about 4 miles to the south-eastward of the "Formigas," or Great Formiga Rock, in the vicinity of the Azore Islands.

Captain Vidal has set the question at rest, and has accurately fixed its position. "Dollabarats' Shoal bears (*S.* 44° *E.*) *true*, from the Formigas, distant 3½ miles, and is in lat. 37° 13′ 30″ N. We anchored close to it, and scoured the ground with our boats. It is a fearful danger; the least depth we found on it was 11 feet at low water. It consists of two or three rocky heads or knolls, which at low water springs have only 11 ft of water on them. At that time of tide their position is marked by several large white patches, which may be distinctly seen, especially so in bright sunny weather. The shoal is near the southern edge of a rocky ridge, which extends from it N. 15½° E. 1 6-10th mile. The soundings over it are most irregular, varying from 14 to 50 fathoms at its edges, but there are no actual dangers on it. The Dollabarat's Shoal is a very insidious danger in smooth water, but in stormy weather the sea breaks over it with great violence."

Tulloch Reefs?—In 1808, Capt. William Tulloch, of the brig *Equator*, of Portsmouth, New Hampshire, on a voyage from Madeira to St. Michael's, was alarmed by some of his crew seeing breakers. He counted distinctly twenty-one heads of rocks, none of which appeared to have much water over them, and two of the rocks showed occasionally above water in the wash of the sea. Their extent, the captain thinks, did not exceed half a mile from North to South, and was still less from East to West. They bore E.N.E. by compass from the highest rock of the Formigas, then in sight, distant about 10 miles, and appeared very black below water.

The breakers on the Tulloch Rocks have been stated to have been several times seen since 1808; among others, by the *Ayrshire*, bound from the Clyde to Dermerara. Mr. Ferguson, the mate of that ship, gives their situation as about *nine* miles E.N.E., by compass, from the Formigas.

Captain J. Henderson, commanding the ship *Fortesque*, from Mauritius to London, states that he saw the Tulloch Rocks on the 17th of April, 1829. Breakers were observed for half a mile East and West. The Greater Formiga and breakers in one bore W.S.W. (by compass), the former about 4 leagues, and the latter 2 miles distant. There appeared to be several heads near the surface of the water.

Notwithstanding all that has been asserted as to the existence of this reef, it was not found by Capt. Wilkes, U.S.N., in 1838; and Capt. Vidal, R.N., in order to set the question of its existence in some better light, sought minutely for it. In the first instance, the steamer was started E.N.E., from the Formigas, and carried out 14½ miles in that direction, sounding, at frequent intervals, with 200 fathoms, without reaching the bottom. She returned, traversing *across* this bearing. On three subsequent trials, with all caution and look-out, no signs of shoal water or soundings were obtained. "We must express our opinion," says Captain Vidal, "upon this reputed

danger, as formerly upon the apparently well-authenticated statements relative to the Aitkin Rock. It looks very like a whale, but, seeing the difficulty there is in discovering small rocks beneath the surface of the ocean, we by no means presume to assert that Tulloch Reef does *not* exist, but we entertain a very decided opinion that it will not be found in the position which has been assigned to it."

Volcanoes between Terceira and St. Michael's.—It is stated that, in 1719, a volcano appeared at 15 leagues to the westward (query, N.W.) of St. Michael's and disappeared in 1723, and was supposed to occupy the situation of that which had appeared in 1638. It is stated that, in 1720, an island appeared at the S.W. extreme of St. Michael's, about a mile from shore; this, perhaps, is connected with the other statement, but it is not very circumstantial. But we have the following accounts of this occurrence: Mons. Ségur Dupreyon has found some documents relating to it in the French colonial archives; the first states that, at the end of 1720, a volcano broke out at 28 leagues off St. Michael's towards Terceira, which formed two shoals. A second statement affirms that it ejected large quantities of pumice. A plan was also forwarded to France of the new island, though it could not be approached in consequence of the jets of boiling water which were thrown upwards of 120 ft. high. The consul announced that, on July the 7th, 1722, this new island had sunk down, and could only be distinguished by breakers.*

In the "Philosophical Transactions" is a much more complete account of this volcano. It is dated May 12th, 1722. In that communication it is described as lying 17 leagues S.E. from Terceira. "The fire broke out on November 20th, 1720, in the night, and the prodigious noise it made caused an earthquake, which shattered down many houses in the town of Angra and places adjacent, to the great terror of the inhabitants." The governor went to the island a month afterwards. "In the afternoon we made an island all fire and smoke; we continued our course till the ashes fell on our deck like hail or snow all night. We bore from it, the smoke and fire roared like thunder or great guns." "Prodigious quantities of pumice-stone, and half-broiled fish, were found floating on the sea for many leagues round the island, and abundance of sea birds hovering about it." "This island is almost round, and supposed to be about 2 leagues in diameter. By good observation, it is in 38° 20′; its long. 26° 33." †

More recently a dangerous shoal has also been reported to exist between St. Michael's and Terceira, seen at the latter end of 1848. These notices were transmitted by H.M. Consul, T. C. Hunt, Esq., to Lloyd's. In substance they are as follow:—Benjamin Pratt, of the *William*, on December 31, 1848, saw breakers, mast high, evidently caused by a shoal, and not by a floating mass. The observations then taken place it in lat. 38° 16′ N., and long. 26° 41′ W. The next is the declaration of Victorino Falcao, of the *Tres Amigos*:—On December 31, 1848, saw a shoal where the sea broke

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* Comptes Rendus de l'Academie Française, 1838, p. 302.

† "Part of a Letter from T. Forster, Esq., F.R.S., to Mr. Machin, Sec. R.S." Phil. Trans., 1722. To this description are attached several views of the island, which were taken at the time.

the height of a ship, at intervals of about 10 minutes. By calculation it is in lat. 38° 18′ N., and long. 26° 50′ W. The third is the declaration of George Perkins, of the *Plymouth* :—On December 25, 1848, I saw the sea breaking heavy at the distance of 2½ or 3 miles to N.N.W. A heavy sea was running, and the water broke 60 ft. high in different places, at intervals of about 10 minutes, as if on an extended shoal, having several heads. It was certainly not a floating obstruction; I consider it a narrow reef, about a mile in length, running from N.N.E. to S.S.W., about 40 miles W.N.W. ½ W. (by compass?) from the N.W. point of St. Michael's.

In Mr. Hunt's observations on the earthquake of 1841, presently alluded to, he says:—"It is by no means a great stretch of hypothesis to suppose that the late earthquake has, like some former ones, been accompanied by the ejection of submarine volcanic matter, which may have been thrown up within a short distance of the surface; so that, in fact, in that part of the sea where there was previously 200 fathoms of water, there may at this moment exist a most dangerous shoal.

"As in navigation the extreme of safety should always be chosen, the commanders of vessels approaching Terceira would do well to keep a good look-out, and be prepared for indications of shoal water, at from 15 to 20 miles to the eastward of it."

Another announcement is, no doubt, connected with the same volcanic centre. It is in the "Nautical Magazine," July, 1843, p. 482, entitled "Malabar Bank." Extract of a letter from Captain Sartorius:—"In lat. 38° 57′ from the observations at noon, and long. 26° 5′ by chronometer, and from supposed most correct bearing of the land, the N.E. end of Terceira, taken at 8 a.m., given lat. 38° 57′, long. 26° 56′, the ship grazed over, apparently, a shoal of about her own length. There was no sudden shock, no appearance of discoloured water, or any other indication of the vicinity of rocks or shoals; and at the time the motion was felt the ship was going 8 knots, wind aft, and studding-sails set.

"I immediately shortened sail, and sounded with 180 fathoms; no bottom. There was too much swell to risk a boat for examination. My own individual opinion is, that it is as likely to have been the shock of an earthquake as passing over a shoal."

This spot will be about 30 miles to the N.E. of the reported situation of the submarine volcano above described, and if the reader will turn to the "South Atlantic Memoir," in the description of the Volcanic Region, he will find that a submarine shock and grounding on a shoal give precisely the same sensation in a ship. That this was a shock that Captain Sartorius felt there can be but very little doubt, and it is most probable from the same volcano. We must therefore recommend to the seaman's notice the cautions of Mr. Hunt, as given above.

But notwithstanding all this evidence, there has been no indication of any shoal or elevation found in a search all over this channel, as no bottom has been found with from 180 to 200 fathoms of line. This, however, only proves that there is no present danger, but it is quite possible that the volcanic action hidden here is capable of raising the bottom to the elevation above described.

TERCEIRA.—The island is fertile, pleasant, and healthy. The lava

districts here, as at St. Michael's, produce excellent vines, although not equal to those of the Canaries and Madeira. The land yields large crops of wheat and other grain, pasture for cattle, and a prodigious quantity of lemons, oranges, and all those fruits of hot and cold climates, which are propagated to the greatest advantage in temperate countries. The capital, as already noticed, is *Angra*, on the South side of the island, having a harbour defended by a fortress, in which resides the governor of the Azores. Angra is distinguished by several handsome churches, convents, &c. Besides this, there is another town, *Praya*, and fifteen villages, all of which contain about 30,000 inhabitants. In the Bay of Angra, and around the island, fish of a good quality is abundant.

The coasts of Terceira are high, and so surrounded with craggy rocks, as to render the island almost impregnable. The interior is in general moderately high, but the western side is higher than the eastern, and is distinguished by a rugged mountain, extending nearly East and West, and of which the western extremity, *Pico de la Serreta*, is the most elevated. This peak may be known by a great break on the eastern side, at a short distance.

The part of the island * in which Praya is situated, is the most fertile of the whole; on which account it was the part selected by the first discoverers for their residence, and its population was entirely agricultural. It is the part from which levies were principally made to resist the landing of an expedition in favour of Don Miguel, in August, 1829; when a small military force, with their assistance, and the possession of the strong forts on the Bay of Praya, beat off the much superior force of Don Miguel.

The town of Praya had, in the year 1614, been totally destroyed by an earthquake, which considerably injured the town of Angra, and was severely felt in the island of St. Michael. Since that time it had escaped injury, although menaced by many severe shocks of earthquakes.

On the 12th of June, 1841, at 4 p.m., a violent shock of earthquake was felt at Praya, extending with diminished violence to the westward. At $5^h\ 25^m$, a second and more violent one was felt; the trembling continued throughout the 13th, and on the 14th an undulation destroyed all the buildings which had been weakened by the former shocks. The inhabitants of Praya then retreated to the fields for safety. During the 14th the motions were slight; but on the 15th, at 3 a.m., a violent trembling and horizontal undulation commenced, and continued, with intervals of about 10 minutes, until $3^h\ 30^m$ a.m., when a strong vibratory and distinctly visible rocking motion of the surface threw down the entire town of Praya, and injured many other parts of the island. The ground remained comparatively quiet until $2^h\ 40^m$ a.m. of the 16th, when another violent shock did further damage. After this no further damage was done, but the island did not become perfectly quiescent until the 26th of June.

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* The following account of the island, and the great earthquake of 1841, we have taken from a communication by Mr. T. C. Hunt, the British Consul at St. Michael's, to the "Nautical Magazine," September, 1841, pp. 631—633.

It was observed, with respect to the whole progress of these phenomena, that the motion was greatest at Praya, where a rent has been left in the ground of about an English mile in length, from the edge of the water stretching westward; and that every convulsion was preceded by a loud subterraneous noise resembling thunder, so exactly varying in intensity according to the severity of the succeeding shocks of earthquake, that the first became the harbinger and guage of the other.

The number of houses destroyed was estimated at 800, besides other considerable damage, amounting to the value of £180,000.

The less severe shocks did not extend beyond the Island of Terceira, others were experienced of apparently equal force at St. George and Graciosa, and only that which destroyed Praya was felt (but not severely) at the capitals of Pico and St. Michael's. At Fayal, and at the eastern end of St. Michael's, no motion was perceived.

It is therefore probable that the origin of this earthquake was a submarine volcanic eruption, and that its position or centre was about 17 *miles due East from the eastern end of Terceira.** This has been practically confirmed by the accounts of the volcanic shoals before described.

Angra lies on the South side of Terceira; it is the capital of the island. At the town provisions are cheap, and in plenty. The bay may be readily known by means of a remarkable forked hill, near the sea, on the West side, named *Monte Brasil,*† and by two little steep islets, called the *Cabras,* or *Goats,* which lie about 4 miles to the eastward of the mount. About 2 miles to the south-eastward of these islets is another, called *Los Frayles,* with breakers near it.

In approaching from the S.W., or South, or S.E., steer directly for Monte Brasil. Should the wind be adverse, when approaching the land, tack boldly without the bay, as there is a sufficient depth over it, and up to the shore.

But beware of a calm, as the currents are very strong and variable. If you have not a leading wind, when sailing up toward the mount, avoid too near an approach to the coast, between it and the westernmost part of the island, as it would in a calm be attended with the utmost danger; the coast being ironbound, a ship driven on it would be in a most perilous situation.

The *Bay of Angra* is open to all winds from S.S.W. by the South to the East. The swell from the S.W., in particular, which sets round Mount Brasil, on the western side of the bay, is tremendous. The ground at the entrance is foul, and ships should always moor to the northward of Fort St. Antonio, which is on the West side of the bay.

Vessels may safely remain in the road in June, July, August, and September, when the winds are light, and prevail from between West and N.W. But on the commencement of winter, the winds from the offing rage so violently, that, upon the least appearance of bad weather, it is requisite to put off to sea, the coast affording no shelter.

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* This proposition has been ingeniously argued out by Mr. Hunt, from the various degrees of intensity that the shocks were felt in the different bearings and distances; by arranging these together, it fixes the centre of the action as above.

† See the particular plan of the Road of Angra on the Chart of the Azores.

Porto Praya, on the eastern side of Terceira, has been described as the largest and safest bay in the Azores. "This bay," says M. Fleurieu, "has the form of a crescent; the point toward the North has, at its extremity, a small islet to the N.E. To lie in the best place, this islet must shut in with the point, and the two towers seen on the bottom of the bay must be brought together; you will then be in 24 fathoms, sandy ground, the town bearing N.N.W. and North. You may also anchor nearer to the shore, in 20 and 16 fathoms. The boats must not attempt to land at the bottom of the bay toward the S.W., on account of a sandbank, upon which they would ground; but they will find a good landing-place near the castle."

The following is a more particular detail of the *Coasts of Terceira*, abridged from Tofiño.

The *Mount of Brasil*, near Angra, is moderately high, and has two small columns or pillars at the top, which serve as look-out places. The hill descends gently toward the North, and at its base, on that side, is the *Citadel* or *Fort of St. Juan*, the chief defence of the island, and particularly of the city of Angra, which stands to the northward and N.E. of it. From the citadel a line of wall and batteries extend to *Fort St. Antonio*, on the East side of Mount Brasil; the opposite or N.E. side of the bay is defended by *Fort St. Sebastian*.

Merchant vessels regularly anchor in the line of the forts of St. Antonio and St. Sebastian, or rather farther in, mooring with the four anchors. This is necessary, the bay being open to the sea from S.S.W. by South to East, and therefore extremely unsafe when winds from those quarters may be expected, the coast being mostly of sharp rocks. Large ships anchor to the eastward of Mount Brasil, in from 30 to 40 fathoms of water, sandy bottom, and they must be ready to get under weigh in the instant that the wind appears to be coming on from the south-eastward or south-westward.

On the western side of the castle of St. Sebastian is a little beach, slightly sheltered by a wall of the castle. It is called *Puerto de Pipas*, and is the spot wherein fishing-vessels are secured, by grounding them on the sand. It may serve as a landing-place when the wind will not allow you to land at the mole.*

The boats of the island come out as soon as any vessel is seen to anchor, and by them supplies may easily be obtained, even while keeping under way, tacking in and out, as they will bring water, wood, and all kinds of provisions.

The *Ponta de las Continendos* is the S.E. point of the island. It presents an eminence, having three peaks on its summit. At about halfway between this and Angra are the *Cabras* or *Goats*, already noticed, which lie S.E. by E. (*E. by S.*) 4 miles from the summit of Mount Brasil, and two-thirds of a mile from the nearest part of the coast. Of the two islets, the eastern is the largest and highest; when seen from the East or West, it appears like a wedge. Between the islets is a channel for row-boats, with from 8 to 10 fathoms of water; between them and the coast a ship may pass, and there are 9, 12, and 13 fathoms of water, with sandy bottom, and rocks near shore only.

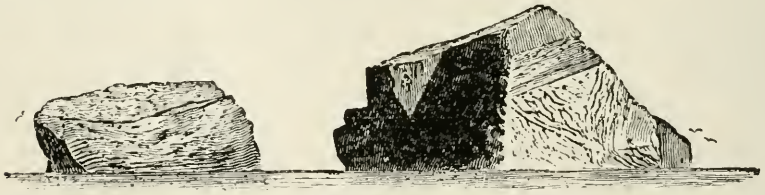
* It is sometimes much easier to land on the rocks under the cliff, on the Mount Brasil side of the bay, than at Puerto de Pipas. A footpath, of difficult ascent, marks the proper spot to attempt landing at.—*A. L.*

The *Frayles*, or Friar's Isle, before mentioned, is a low islet, having two pyramidal peaks. A shoal extends from the S.E. side of it, about a cable's length, over which the sea breaks. Several cliffs on the islet give it the appearance, at a distance, of several isles. A ship may pass, with all safety, in the channel between this and the Cabras, the depths being from 60 to 75 fathoms, gravelly bottom, and clear ground.

The eastern coast of Terceira is generally broken, rocky, and dangerous. The easternmost point is that named *Malmeranda*, which is high and oblique, with a large shoal near to it, which shows itself at low water. To the south-westward of this point is the town of *Praya*, defended by batteries. The bay on which the town is situate is of great depth, with good holding-ground, and a fleet may anchor here, sheltered from the South, by the West, round to the North, but entirely exposed to the eastward; the safest anchorage, therefore, is with Point Malmeranda in a line with the northern islet, Cameiros, and the highest tower or steeple of the town, which is the northernmost, open to the West. Here is a depth of 25 fathoms, with sandy bottom; and, as at Angra, supplies may be obtained from the boats of the place.

Remarks on Terceira, by Captain Livingston, 1822.—"At about 6½ or 7 miles North of Angra is a valley near the summit of the mountain; a great deal of steam issues from crevices of the earth, or rather clay, which clay, I am informed by a scientific gentleman here, is actually lava, decomposed by the action of sulphuric acid. Some of the clay looks, when cut by a knife, much like castile soap; it is of various hues, and the natives of Terceira use it as paint. There are small quantities of sulphur formed around some of the apertures. The steam which rises is very hot; we cooked some eggs by laying them among the clay, at mere cracks whence steam issued. My thermometer ranged only to 152° of Fahrenheit's scale. I exposed it to the steam at the first aperture I reached, but the mercury rose so rapidly, that, from fear of bursting the tube, I was obliged to withdraw it, I think, in about three or four seconds. Persons visiting Angra, who have any curiosity in their composition, should see this *furnaso* or *souffriere*. The access to it is by no means very difficult, though, if you ask any of the Portuguese, they will describe it as accessible only at some periods of the year. One may ride to within less than half a mile of it. Ponies, or asses, and guides, may readily be hired.

"Some vessels, mistaking Praya for Angra, have stupidly run in there; but the Goats and Mount Brasil are sufficient to show the most entire stranger the difference. I annex a sketch of the former.



"The *Goat Rocks* were sketched at nine a.m. 25th January, when about 2 miles distant, the weather being hazy, and the tops of the moun-

tains of Terceira covered with dense masses of clouds. Point at the left bearing N. by E. by compass, and that at the right hand N.E. ½ N. also by compass.

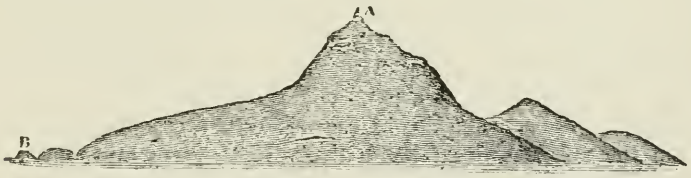
"Bloody flux is very frequent both among strangers and natives, and is often fatal. A Scottish surgeon there told me it was the worst disease he met in the island.*

"Vegetables are excellent and cheap. Poultry and eggs good and reasonable; beef and mutton tolerable, the former about threepence per pound. Some of the island wine is tolerably good.

The *North Coast of Terceira* should not be approached by a stranger, as it is rocky and dangerous. The western coast is also inaccessible.

PICO.—This island derives its name from the remarkable peak or volcanic mountain which stands upon it. The summit of this mountain, whose sides are neither very steep nor uneven, is terminated by a small sugarloaf, so very regular, that one would think it had been made by art. The height of the peak, above the level of the sea, according to the geometrical operation of the French astronomers, is about 1,172 English fathoms; by the survey of Captain Vidal it is 7,613 ft.; and consequently, in clear weather, it can be seen 24 or 25 leagues off; but it is frequently so obscured by clouds as not to be seen at any distance. When the southernmost point of Fayal is in a line with the peak, E. by S., this mount appears as shown below.

The peak has been described as filled with dark volcanic caverns, which have frequently emitted smoke, flames, and ashes, to a considerable distance. At the foot of the mountain, toward the East, is a spring of fresh water, generally cold, but sometimes so heated with the subterraneous fire as to rush forth in torrents, in a boiling state, and sending forth a stream of sulphureous vapour, vitrified stone, &c.



Pico, when the Peak (A) *bears E.S.E. by compass*—(B) *E. by S.*

Pico contains about 22,000 inhabitants, who occupy three towns and eleven villages. The soil being stony, little grain is produced, and the greater part of the wheat and maize for consumption is imported from the neighbouring islands. The wine is the staple commodity, and is reputed the best in the Azores. This, with brandy, is exported in considerable

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* It deserves to be known, that the size of a hazel-nut of Castile soap, scraped fine and dissolved in about three wine-glasses of boiling water, to which add half a wine-glass of good spirits and a few lumps of white sugar, scarcely ever fails of curing bloody flux. Two or three doses may be required. I have tried it on myself and others with great success. —*A. L.*

quantities. The cattle are various, numerous, and excellent; fruit is abundant, and equally fine. Besides these they have cedar and other timber, including a beautiful kind of yew, called *Teixo*, which is remarkably solid and fine.

The S.E. point of the island, which is rather low and sloping, is named *Ponta de la Ilha;* a ridge extends from it to the eastward, 1 cable's length. The next projection on the South coast is *Pta. de Calheta,* or Nesquin, distant 5 miles W. ¾ S., *true;* between are the little harbours *Muelle de Manana* and *Nesquin,* fit only for coasters, which may ground on the sand, the bottom being generally rocky. At N.W. ¾ W. (*W. by N.*) 6¾ miles from the Pta. de Calheta is the *Pta. de Arrife,* which is rather more elevated: the coast between continues rocky, and is not to be approached by strangers. Eight miles N.W. ¾ W. (*W. by N.*) from Pta. de Arrife is that of Santa Catalina; the coast between forms a slender bay, in which, at 2½ miles from the former, are the town and lagoon of Lagens; the latter communicates with the sea by means of a bar, over which the coasters pass at high water. The fishermen have another place of shelter, in *Puerto Praima,* which is on the N.E. of the point Sta. Catalina.

On the S.W. and W. sides of the island is nothing remarkable, but its rocky coast and islets. From the Pta. de la Baxios, on the N.W. side, breakers extend outward to the distance of nearly a league, during a gale.

Off the most prominent part of the western coast are the little port and isle of La Magdalena. From the town, which stands here, the greater part of the produce of the island, for exportation, is shipped off for Fayal in small row-boats. The islets are surrounded by rocks; but very near the latter the depths are 6, 7, and 8 fathoms, rocky ground.

The North coast, from Pta. de los Baxios to the East end of the island, is altogether rugged, and may be considered as inaccessible.

FAYAL.—This island has been celebrated for its excellent pastures, fish, wood, &c. The air is always mild and pure; the cold of winter never felt, and the heat of summer always tempered by refreshing winds. Its inhabitants are computed at about 17,000. The island produces wheat and maize, sufficient for itself and a part of Pico. The cattle reared here are not sufficient for the consumption of the island, and supplies are, therefore, sent from the neighbouring Island of St. George, which produces a great number. The annual produce of wine is scanty.

Fayal, when the point (A) *bears N.E. by E. ½ E. by compass, and* (B) *E. by S.*

Horta.—The chief town is *Horta,* on the S.E. side;* and there are, besides, nine villages on the island. The name Fayal is understood to be derived from *Faya,* the beech tree, with which, and other wood, the island abounds.

* See the particular plan of the channel between Fayal and Pico, on the chart. For a urther description of these islands, see hereafter.

In the journal of Mr. Keilor, an intelligent Master of the Royal Navy, it is stated that those who run for Fayal should not depend on the peak of the next island as a guide, because it is sometimes covered for five or six days successively.

Mr. Keilor adds, Fayal has a good bay, opposite to Pico, which is formed by an isthmus, extending to the S.E., and a point about 1½ mile to the north-eastward. Water, in general, is bad and scarce.

The S.E. point of Fayal is a mount, with a hermitage on its summit, dedicated to *Our Lady of Guia* (*N.S. de la Guia*). The North side of this is connected by a neck of land to a smaller mount, of a black colour, *Caimado*, at the foot of which the town of *Horta* commences. Near the mount, on the West, is a sandy cove, *Port Pim*, where, in fine weather, some small vessels load and discharge their cargoes, but it is quite open to the S.W.

The northern point of the Bay of Horta is named *Espalamaca;* its bearing and distance from that of La Guia are N.E. ¾ E. (*N.N.E.* ½ *E.*), 1¾ mile nearly. At the bottom of the bay is a beach of black sand, which commences near Point Espalamaca, and terminates at Mount Caimado. Within it is the town, facing the sea. In the latter are two very remarkable buildings, nearly alike; one of these is close to the sea-side, and was formerly called the Company's College; the other is in the most westerly part of the city, upon an eminence, and near the Carmelite Convent. These objects in a line bear nearly N. by W. ½ W. (*N.* 42° *W.*).

Nearly in mid-channel, between Fayal and Pico, is a rocky shoal, the *Chapman Rock*, of 3½ fathoms; it is about 20 fathoms in extent from N.E. to S.W. (*N.N.E.* to *S.S.W.*), and 10 broad. The marks for it are the Company's College and Carmelite Convent, above mentioned, in one; Point de Espalamaca, N. by E. ¼ N. (*N. by W.*) 2 1-10th miles; and the hermitage of Guia, N.W. ½ N. (*N.W. by W.* ¾ *W.*) 1 6-10ths miles. See, further, the particular plan in the large chart.

The regular anchorage of Fayal is in the bay opposite to the town of Horta. It is the best anchorage in the Azores, on every account, excepting that it is open to the winds from North to N.E. and from S.E. to S.W., and these winds are frequent in winter. That from S.E. is very destructive, as it blows right in. Those who anchor should, therefore, always be prepared for a start on a shift of wind. The safest method is to let go the anchor in 35 or 40 fathoms, where the bottom is of sand, at about 1¼ mile from the town, which will be with the Point of *Joao Diaz* a little open to the right of Point Espalamaca, and the Company's College in the town a little open to the southward of the Carmelite Convent, already described. From this spot a ship may depart with any wind.

In the summer season and favourable weather, the general anchorage is with the two buildings in the town, as above described, but nearer to the town, in 25 fathoms, sandy bottom; small vessels proceed further in, to 20 to 15 fathoms.* There are means of repairing vessels at Horta; but, as

* Mr. William Lane, agent to Lloyd's, in November, 1832, gave notice that, for the use of vessels passing through the channel between Fayal and Pico, or those requiring assistance from the shore, he had erected a flagstaff behind the *Castle of St. Cruz*, Fayal, and

there is only one establishment, the charges are exorbitant. In 1869, 43 vessels visited the anchorage, and in 1870, 62 vessels.

A breakwater, which will convert the roadstead of Horta into a valuable harbour of refuge, was commenced in 1876. Mr. Consul Read, in March, 1877, writes:—"As regards the works for the breakwater at Fayal, I am informed by Mr. Vice-Consul Dart, in March, 1877, that operations hitherto have been confined to land, such as the purchase of land for quarries, the erection of stores, sheds, &c. Four cargoes of timber have been imported from the Baltic, coals, iron, and some machinery from England, and the amount expended to the present date, including all labour, salaries to officials, and two locomotives (not yet arrived), is calculated not less than 38,000*l.* to 40,000*l.*"

To sail in for the Road, if from the *northward*, no further direction is requisite, as the way is perfectly clear. If coming in from the S.W., with a free wind, the regular passage is between the mid-channel shoal and Mount de Guia; or, if more agreeable, between the samo shoal and Pico, according to circumstances. With the wind from the West or N.W., take especial care to avoid the shoal, by observing the marks for it, above described.

If, on approaching the road from the S.W., the wind should be dying away from the eastward, and you intend to tack, so as to gain the anchorage, keep over toward Pico, within the distance of a mile or a mile and a half; because at a little further out the bottom is rocky, and you cannot anchor, in case of necessity; besides, by proceeding thus, you will be free from variable eddy winds and calms, which are caused by the mountains; and the coast is sufficiently clear.

Southern Coast of Fayal.—The point of *Santa Catalina*, which is 3¾ miles nearly N.W. by W. ½ W. (*W.* ¼ *N.*) from Guia Point, is of low and black rocky land, and it likewise has a hermitage; between these points is the cove of *Feteira*, with its beach and village. Near it are several islets.

The Point *Castelo Bianca* is the S.W. point of Fayal. It appears like a little round mountain of moderate height, sloped on every side, so that at a distance it appears like an island. The coast hereabout is rocky, and affords no anchorage.

At the West end of Fayal are the two islets named *Capelinos*, lying in a South (*S.S.E.*) direction. Between them and the coast is a channel, which in fine weather admits fishing boats.

The point of *Jorge Lourenzo* is the northern point of Fayal. Its upper part is high and sloping. From this point to the N.E. point of *Riveirina* the coast trends S.E. ¼ S. (*E.S.E.*). Point Riveirina is high and sloped, and forms a round front of about half a mile; at the foot of it is a low point, with three islets. S.W. ¾ S. (*S. by W.*) from this point, at 2 3-10th miles, is that of Joao Diaz, which is low, black, and rocky, with rocks at its extremity. Between the points the coast forms a slender bay; the land is

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provided the telegraph flags of Captain Marryat, so as to enable them to communicate any information they wish to be reported, or to acquire immediate assistance in case of distress.

high and oblique, and it presents, near the middle, a remarkable slope of a red colour, which may be seen from the mid-channel shoal, called the Shoal of Fayal.

At nine-tenths of a mile to the southward from Point Joao Diaz is that of *Espalamaca*, on the North side of Horta Bay. It is high and sloping, with a small round-front, having a vigia, or look-out, on its summit. Between these points the coast is a little indented, and has a beach, with a church at the bottom of it. Trading-vessels at Port Magdalena, on the opposite side, when assailed by violent winds from the southward, frequently bear up, and find good shelter here.

ST. GEORGE.—This island lies at the distance of 12 miles from Pico, and is separated from Graciosa by a channel 20 miles broad. It is a long, narrow island, about 29 miles long, and a little more than 3 in its average breadth. On its South coast is the little town called *Villa das Velas*, or *Vellas*, with a port where small vessels may lie sheltered from all winds.

This island, when Tofiño described it, contained more than 11,000 persons, in three towns and seven villages. He says that it produces much wine of a good quality, which it exports to Terceira and America. The island has been famous for its cattle, with which it supplied other islands, and its cheese is said to be fine. The produce of wheat and maize is equal only to the consumption of a part of the inhabitants, as the lower class substitute the root of the yam. Wood and fresh water are abundant.

On the 1st of May, 1808, a dreadful volcano, seen from Fayal, burst out about the centre of this island, in the midst of fertile pastures, about 3 leagues S.E. of Vellas. On the 3rd a crater was formed. In two days it had thrown out cinders, or small pumice-stones, which a strong N.E. wind had propelled southerly, and which, independent of the mass accumulated around the crater, had covered the earth from 1 to 4 ft. in depth, half a league in width, and three leagues in length; then, passing the channel, had done some injury to the eastern end of Pico. The fire of this large crater had nearly subsided on the 3rd of May; but in the preceding evening another small crater had opened, 1 league to the northward of the large one, and only 2 leagues from Vellas. In a short time the island, heretofore rich in cattle, corn, and wine, was nearly ruined; and a scene of greater desolation and distress had seldom been witnessed in any country.

The channels among the Azores are in general clear and deep, and may be navigated at all times; that, however, between St. George and Pico should not be attempted, unless in settled weather, or with a steady breeze, for a sudden calm may prove fatal, as a strong current runs through the channel, according to the state of the tide.

The *Ponta del Topo* is the easternmost point of St. George's Island. This point lies W. by N. (*W.S.W.* $\frac{3}{4}$ *W.*) 27 miles from the summit of Mount Brasil, in Terceira. It is of moderate height, with rocks around it, and near its eastern part is a low islet, likewise surrounded by rocks.

From Pta. del Topo to *Pta. del Norte Grand* the North coast presents nothing remarkable. There are several breaks on it, but it is mostly low and regular. Hence to the West end of the island, *Pta. del Rosales*, it is

more rugged and barren. Off the point last mentioned are several islets, of which two very high pyramidal ones are remarkable; one of these is at the foot of the point, and the other half a mile to the S.W. of it. To the *W. by S., true,* of Point Rosales, the pilots say that there is a rocky shoal of 7 fathoms. The sea may break over it in a storm.

From Pta. de Rosales to the *Morro Grande* (Great Hill), near the Port of Vellas, the coast trends S.E. by S. ¼ S. (*S.E. by E.*) The Morro is high, of a blackish colour, and has a vigia, or look-out, on its summit. To the N.W. of the Morro, and on its skirt, is an indent of the coast, wherein several vessels have been lost, by mistaking it for the Port of Vellas, the bottom being all rocky, and a vessel, once in, cannot leave it without a change of wind.

Puerto de las Vellas.—At 1½ mile S.E. ¾ E. (*E. by S.*) from the outer point of the Morro Grande is Pta. la Caimada, rather low, with a small castle. Between the two points is the Bay or Port of Vellas, sheltered from winds from N.W., by the North to S.E.

In the bottom of the bay, on the shore, is the town of *Velas* or *Vellas*, the chief town of the island, and on the S.E. side of this is a small mole, having 3 fathoms within it, but with rocky bottom. The regular anchorage is to the South (*S.S.E.*) of the mole, in 9 fathoms, fine black sand. Vessels moor with two anchors to the N.W. and S.E. This is a place of little consideration.

From Point Caimada, on the eastern side of Port Vellas, the coast by the sea continues low and rocky, but the land within rises to a good height. Thus it continues to the Pta. de los Monteros, the S.E. point of the island, which is high and sloped. Four leagues from the Bay of Vellas is the *Point de Caleta*, whence a high mountain rises, with a gentle acclivity, and close to it, on the East, is a town of the same name, whence much wood is exported to the neighbouring islands.

GRACIOSA.—Graciosa is said to take its name from its beauty and fertility in corn, fruit, pasture, and cattle; supplying Terceira and several of the other islands with a great part of its produce. It is the most fertile of all the Azores, and has about 8,000 inhabitants, distributed in two towns and two villages. The greatest extent of the island is only 8½ miles, but in this extent the quantity of barley which is produced is almost incredible, together with wheat, maize, wine, and all kinds of fruit and vegetables. Of sheep, hogs, and fowls, the inhabitants have more than they can consume. The only scarce article is wood, for this is obtained from St. George's and Pico. The chief town is Santa Cruz, on the N.E. side.

Ponta Blanca is the S.W. point, and Carapacho the S.E. The mountains over these points appear at a great distance like islands, particularly on approaching the South side from the S.W. Point Carapacho is low toward the sea, and has several islets about it; but at a little distance inland it is high and craggy. At 2 cables' lengths S.E. ¼ S. (*E.S.E.*) from the point is the Islet *Abajo*, with others in its vicinity, but between it and the point the largest ship may pass, should it be necessary, to the anchorage of *Praya*, on the eastern coast.

Between the Point Carapacho and the Ponta dos Fanœs, 1½ mile N.E. ½ N. (*N. 14° E.*) the coast is almost uniform and clear. At the last, the Bay of

Praya commences, the North side of which is *Pta. Negra*; the bearing and distance between are N. by E. (*N. 15° W.*) 1½ mile. Pta. Negra is low and rocky, and near it stands the town of Praya.

An islet, called the *Isle of Praya*, lies at half a mile E. ¼ S. (*E.N.E.*) from Point Negra; it is low on the West side, but rather higher on the East, and there is a passage between it and the point. At the distance of 1½ cable to the southward of the islet is the anchorage.

At 3 miles N. ¼ E. (*N.N.W.*) from Point Negra is the Point of Josef Ferrer, which is very low, being even with the water, and having a dangerous shoal, at about 2 cables distance to the E. ¼ S. (*E.N.E.*) The coast between these points is rather regular than otherwise, with a few little bights; of these bights, the first is close to Point Negra.

The best anchorage about the island is with the Islet Abajo, lying near the S.E. point, in a line with the westernmost part of Praya Isle, or rather a little open; this is off the southern extremity of a great slope of land, extending toward the Point of Josef Ferrer. The depths are from 30 to 40 fathoms, sandy bottom. Here vessels load and unload, and are ready to be off with any winds; but they lie sheltered only from South by the West, nearly to North. All the goods from the town of Santa Cruz are brought to this anchorage to be shipped, as they have no other.

On the West of the Point of Josef Ferrer are the bay and town of Santa Cruz. The coast is low, and the land rocky, with scattered fragments of rock about it. Close to the town, on the S.W. side, are three small hills near each other, and a church is on the highest part of every one of them. These, therefore, are good marks for the North side of the island.

The *Ponta de Pico Negro* is the North point of the island; it is high, oblique, and of a very black colour. The coast hence to the S.W. continues high and rocky. From the *Pta. de Fozzo de Porco*, the western point, half a mile S.W. ¾ S. (*S. 10° W.*) is the *Point of Jorge Gomez*, low and rocky, with a church near it. There is landing here. At 3¾ miles from that point is *Point Blanca*, very high and sloping, within which, at a short distance, is the highest mountain on the island, 1,378 ft. high. The coast between is of high rock. On the summit of Pta. Frayle, northward of Point Blanca, is a stone that resembles a man.

At S.E. ½ S. (*S.E. by E. ¾ E.*) 2½ miles from Point Blanca is the low and rocky Point of Folgo; the coast between forms a bay, and the village of Folgo is at the bottom of it.

FLORES.—This island contains about 7,000 inhabitants. It has two towns, both on the eastern side, *Sta. Cruz* and *Lagens*, and four villages. The chief productions are yams, wheat of excellent quality, cattle, sheep, and hogs. The exports are wheat, cloths, bacon, with the weed or moss called orchilla, used for a dye, as already noticed. The latter is found clinging to the rocks and declivities, and is not obtainable without great trouble and danger.

The island is very mountainous, but much more so towards the South than the North. The fort of the town of Santa Cruz is in lat. 39° 27′, and long. 31° 8′ 37″; and to the West of it, in the interior of the island, is a remarkable peak, the Morro Grande, 3,687 ft. high. The land is well cul-

tivated, and has abundance of water, falling down in numerous cascades from the heights.*

Ponta del Gada, the North point of Flores, is of moderate height, smooth on its summit, not very projecting; but at its base is a cluster of islets, extending outward a quarter of a mile; the ground around them is clear.

Ponta Ruiva, the N.E. point of Flores, is high, sloped, rugged, and obtuse. At the foot of it is an islet, called the *Pan de Azucar*, or Sugar-loaf; a fishing boat may pass between. In the bay to the westward of Ponta Ruiva there is anchorage in 25 fathoms, sandy ground, sheltered from winds from S.E. by the South to W.S.W. It is frequently resorted to for water, or by vessels that are compelled by the wind to quit the eastern side of the island.

The point of *Santa Cruz* is $2\frac{3}{4}$ miles S. $\frac{1}{4}$ E. (*S.S.E.* $\frac{1}{2}$ *E.*) from Point Ruiva. It is low and rocky, with several rocks about it. In the interval is the islet of Alvaro Rodriguez, very near to the coast; and to the S.E. (*E.S.E.*) of this is anchorage, in 36 fathoms, sandy bottom, sheltered from the West and S.W. At *true* South, three-quarters of a mile from the point, is the castle of Santa Cruz, which is very near to the town, the principal port of the island.

At $1\frac{3}{4}$ mile southward from the castle of Santa Cruz is *Ponta Cabeira*, low and rocky land, which rises with a gentle acclivity to the distance of a mile. Between these points the coast forms a bay, with a beach and a small river at the bottom of it. This bay is the best anchoring place about the island, and is sheltered from all points between N.N.E. by the West to S.W. The proper depths are in from 35 to 40 fathoms, sandy ground. This is the nearest anchorage to Santa Cruz, and therefore the most frequented.

At $1\frac{1}{2}$ mile S.W. by W. (*S.S.W.* $\frac{3}{4}$ *W.*) from Point Cabeira is that of Lomba, which is high and oblique; between these points the coast forms a bay, with a beach and small river at the end of it. A vessel may anchor in this bay, in 25 fathoms, sandy bottom, but it is not so well sheltered as that to the northward, being open to easterly and southerly winds.

From the *Point of Lagens*, which is 4 miles to the south-westward of Point Loma, a ridge of rocks extends to the distance of $1\frac{1}{2}$ cable to the S.S.E. At $2\frac{1}{2}$ miles S. by W. (*S. by E.* $\frac{1}{4}$ *E.*) from Point Lagens is a rock or shoal, of $4\frac{1}{2}$ fathoms; its size is about that of two ships, and appears, when near it, like a large flagstone. Between it and the coast is a great depth of water.

In the little bay, on the North side of Lagens Point, is the town of Lagens, having a large church, which is a useful mark for this part of the coast. A vessel may anchor very well in this with a wind between North by the West to S.W. by W., in 25 fathoms, sandy ground. This anchorage is much frequented, because a vessel can here get under way more easily than at Santa Cruz, having better room for working out.

From Lagens Point westward the coast rises in height to *Point de Roca Alta*, at a little distance from which, toward the North, is the highest part

* The anchoring ground about the island is generally at beyond the distance of a mile from land. Within that distance the ground is rocky, and much further out it is the same.

of the island. The Point of Lope Bas, which is nearly a mile W. by N. ¾ N. (*W.* ½ *S.*) from Lagens Point, is low by the sea, but within high and sloping. That of Roca, 1½ mile further, is obtuse, very high, sloping, and black. The coast here is nearly straight, high, and rugged.

The *Ponta de los Ilheos Agua Caliente,* which is low and rocky, is so called from a mineral spring which exists here, and of which the water is hot. Between this and the Point Roca Alta is a bay, with anchoring ground in 25 fathoms, sandy bottom. There are several islets at the foot of the former point.

The *Pta. de Catarinas,* with its islets, lie 1½ mile more to the northward. The coast between is wholly rocky. At 1¾ mile further to the N.N.E. is *Pta. dos Bredos,* high sloping land, of a whitish colour, with islets at its base. One of the latter, on the South side of the point, resembles a column. The coast between affords anchorage in 20 or 25 fathoms, sandy ground.

The *Pta. del Baxio,* which is very low, is 2¾ miles to the northward of Pta. dos Bredos. The coast between is rocky, but you may anchor off it in 32 fathoms of water, sandy ground, and sheltered from N.N.E., East, and South. Close to Baxio or Shoal Point is a very remarkable church, that of S. Pedro or St. Peter.

Fanaes.—At 2⅞ miles N.N.E. ¾ E. (*N.* 6° *E.*) from Baxio Point is that of Fanaes, which is not very high by the sea, but it forms abruptly like a mountain, and is of a black colour. The bay in the interval is that of San Pedro, which has anchoring ground in 25 or 30 fathoms, bottom of sand; and here water may be readily obtained from a cascade that falls from the mountains, by means of a hose, so as to fill the casks without taking them out of the boat. The Islet Monchique lies at rather more than a mile N.W. ½ W. (*W.N W.* ½ *W.*) from Point Fanaes. The depth between is sufficient for any ship.

The following observations upon this place are by Mr. E. May, Master of H.M.S. *Skylark*:—

"At daylight, bore up for the Bay of Fanaes; at 5^h 10^m shortened sail, and sent a boat for water. The beach consists of large stones, none smaller than a man's head. These stones extend from the beach two or three boats' lengths, making it dangerous for boats to land.

"The best landing-place is a passage between a point of rocks that lies to the South of the beach. From thence you may procure water, from a fountain, about half a mile from the beach, employing small casks, and at the rate of three to five tons per day, by employing natives, if the weather is fine, and the wind between S.S.E. and N.E. With any other wind, particularly if blowing hard, there would be too much surf, and the passage too narrow, in such weather to enter. This place may be known by a very high, steep mountain, a little to the left of the landing place, from whence the Island Monchique bears N.W. 1½ mile. Between the island and the shore is a clear passage for any ship; but she should borrow towards the rock, as a reef projects a cable's length from thence, although there are no hidden dangers in the passage.

Refreshments.—"At this place, by the assistance of shore-boats, about four tons of water were obtained in ten hours. The place abounds in poultry, bullocks, sheep, pigs, vegetables of all kinds, and eggs, all very

cheap. Those who came off to the ship were well dressed, clean, healthy people. The shore of the island is bold, and may be approached to the distance of a quarter of a mile. Leaving Fanaes, I would recommend vessels to run due West for 2 or 3 miles, to get clear of the high land to the North of the landing-place, by which they would avoid being becalmed under this land when the wind is from N.E. to S.E., and would be enabled to run clear of the island. Corvo has also a bold shore, and can be seen off deck 55 miles distant, as was proved by us the day after leaving the island, both by log and observation. Flores may be seen still further off, as it is higher than Corvo."

It is important to know that such useful refreshments can be so readily procured. A tedious homeward passage may make this place of the greatest benefit. This has been confirmed by Captain Henry Toynbee, in 1859. Captain Toynbee says:—"Twice have I hove-to for a few hours off Santa Cruz, and taken in as many bullocks, pigs, sheep, fowls, &c., as were required for a few days' fresh mess for the invalid troops on board my ship." In July, 1859, the *Fitzjames* put in here in a distressed condition at Captain Toynbee's recommendation, and was received with every kindness by Mr. M'Kay and his family. The captain procured all he required. Bullocks, £4; potatoes, 3s. the bushel; eggs, 5½d. a dozen; fowls, 12s. a dozen This knowledge may be the saving of much misery to a homeward-bound ship after a protracted voyage.

Ponta Albernas is the N.W. point of Flores. It is moderately high, sloped, and of a red colour. Between it and Point Fanaes is the islet of *Maria Gadella*, which is high and round. W. by N. ¼ N. (*W. by S.*) from this islet is anchorage, in 30 or 40 fathoms, sandy ground. From the point eastward to Pta. del Gada, already described, the coast is entirely rocky.

The bank of soundings is nearly of the same form as the island, except that to the North it extends further off than elsewhere. From the depth of 200 fathoms, which is met with 5 miles off on the meridian of Ponta Delgada, the soundings diminish gradually up to the point, near which the depth is 22 fathoms. The same may be said of all the coasts, only that the narrower the bank, the more rapid the descent.

To the East the mean breadth of the bank is 2 miles; at this distance the depths are above 100 fathoms; at the outer edge on this side the bottom is uniformly sand, or coral and sand, sometimes to the northward, sand and shells. To the South, on the parallel of Pta. Lagens, the bank is not more than 1⅔ mile in breadth, but its edge trends in a W. by N. direction, so that at Pta. Ilheos it is nearly 4 miles broad. The bottom is sand as far as this. On the West coast the medium breadth is about 2½ miles. The quality of the bottom on this margin is sand, but sometimes rock, or sand and coral. Excepting the two shoals, *Escolar*, with 27 ft. water off the South side, and the *Penra de Laranjeira*, with 11 fathoms at 1½ mile *S.* 16° *W.*, *true*, from the S.W. point, there is no danger on the surrounding bank. But here and there are rocky patches, which it is best to avoid in anchoring. A general remark on the anchorage of Flores is, that a position should be taken at more than a mile from the land, as nearer than that a rocky bottom is more frequently met with.

Reported Reefs.—Between Fayal and Flores, and off the latter, it is

stated that some rocks exist. They were announced by M. M. Ferreira, of the Brasilian brig *Constante*. The first showed above water, at low water, in lat. 37° 56′ 20″ N., long. 33° 4′ 8″ W., and has been named *Constante Reef*. The second, *Ferreira's Reef*, is nearer the islands, and in lat. 38° 26′ 44″, long. 30° 25′ 10″; the sea broke on this. Nearly on the same reported position as the first reef, another announcement, under the name of the *Rhoon Rocks*, was issued, in the "Nautical Magazine," July, 1844. This was an extensive group of rocks, some of them more than 16 ft. above water; lat. 38° 32′, long. 33° 16′. Again, a rock, called the *Atila Rock*, was announced in 1857 to lie in 36° 31′ N., and 32° 24′ W., or 200 miles W.S.W. of Fayal, and a singular warm mist and boiling sea was passed through on November 15th, 1857, by the *Estremadura*, in 39° 57′ N., and 25° 50′ W. All these reports seem to indicate a series of dangers which are very perplexing to deal with, for after repeated searches, they have not been again met with. But the notice of them here will attract attention and induce caution.

CORVO is the northernmost of the Azores, and is formed by a single volcanic mountain, $3\frac{1}{2}$ miles long, North and South, and $2\frac{1}{4}$ East and West, or $9\frac{3}{4}$ miles in circuit. The extinct crater of this mountain is called the *Caldeira*, and occupies all the N.W. part of it, and is $3\frac{1}{4}$ miles in circumference. The highest part of the ridge surrounding the Caldeira is on the S.W. side, and is 2,548 ft. in height. The East and West margins are lower, in some places not exceeding 1,434 ft. Its bottom is occupied by two small lagoons, the surface of which is 1,273 ft. above the sea, and 1,275 below the highest peak. The bottom is cultivated, and used for pasturage, as indeed the greater part of the island is. The summit, even in summer, is so frequently capped with clouds, that rills of water were running down the mountain in the month of August.

The lower land of the S.W. end of the island has all the appearance of being added to the original portion by an eruption of lava, and is diligently cultivated. The only inhabitants on the island are comprised in the village of Corvo, standing on the East side of the South point, on a rising ground close to the coast, and containing 160 or 170 thatched stone houses. They are dirty, and have an uncomfortable appearance, separated from each other by filthy lanes. At the South end of the village stands the church, a small stone building with a square tower and short spire, which, being kept well whitewashed, is a good sea-mark. About 250 yards S.W. by W. from it there is a little rocky hill, surmounted by an antique horizontal mill. The population in 1843 was 784 persons; 383 males, 401 females. They are poor, primitive, and contented. The church is in lat. 39° 40′ 9″ N., long. 31° 7′ 16″ W.; variation, 27° W. It is high water, full and change, at $12^h\ 25^m$, and the rise of tide 3 feet 6 inches.

Ponta de Pesqueiro-alto is the South end of the island. On its eastern side, facing the village, is a small stony beach, where a few fishing-boats are hauled up. *Ponta de Casa* bears N. 52° E, $1\frac{1}{3}$ mile from it. It is a sharp, well-defined point; and at the distance of 60 or 70 yards from it there is a rock just visible above water, on which the sea at times breaks violently, and there is a similar rock a quarter of a mile N.N.E. of it. *Ponta de l'Este* is the next point, and is *N.* 16° *E.*, distant 1 mile; and the next is *Ponta de*

N.E., a bold bluff, 760 ft. high, and 1½ mile *N.* 16° *W.* from the last. The cliffs increase in altitude as you proceed northerly; and to seaward of the Ponta de N.E., bearing *N.* 51° *E.*, one-third of a mile off, is a small block of rock, steep-to on all sides, with 3 or 4 ft. over it at low water. Proceeding north-westward, the next point is *Joao de Moira*, *N.* 57° *W.* two-thirds of a mile, and thence to the North extreme, *Ponta de Norte*, *N.* 79° *W.*, about the same distance. The coast between these two points presents a series of high inaccessible cliffs, fronted as before by a narrow belt of stones. From the top of the cliffs the land rises with great abruptness to the margin of the Caldeira, a height of 2,200 ft., where the horizontal distance from the sea does not exceed 2,500 ft. Ponta de Norte is a high rock, 368 ft. high, jutting out 150 yards from the coast, inaccessible from the sea, and, when seen from East or West, shows an overhanging face to northward. About West from this, one-third of a mile, is a small elevated islet of naked lava, and S. 47° W., one-fifth of a mile from this, is *Ponta de Turrais*, the N.W. extreme of the island. It is very remarkable; it runs directly down from the North edge of the crater into the sea, a sharp, serrated ridge of dark lava. At 300 yards North of it, with Ponta de Norte bearing *East*, there is a sunken rock, on which the sea breaks violently. In rounding the island it will be advisable not to near this point in less than 20 fathoms.

The next extreme point, South of Ponta Turrais, is *Ponta d' Oueste*, bearing *S.* 14° *W.* 1⅔ mile, the coast between being partly a steep declivity, covered with shrubs and wild vegetation. To the southward of this the coast consists of lofty cliffs, and at nearly three-quarters of a mile South of it is a small, low, detached rock, named *Ilheo de Mulher*, 50 yards off the beach. From this the coast runs *S.* 27° *E.*, a mile to the *Sugar-loaf Rock*, a mass of lava standing at the base of a bold, cliffy point. Hence to the southward the coast consists of a ragged outline of steep cliffs, and then a low coast of very broken outline, fringed by numerous rocks, to the meridian of the old horizontal mill previously mentioned. This portion of the coast is fronted by innumerable rocks, projecting from the shore in narrow ridges of broken lava to an average distance of 200 yards. In strong winds the sea rolls over them in enormous breakers, but the danger is not so wide as it appears to be.

The bank surrounding the island is generally steep, and very abrupt on its outer edge. At Ponta de Casa it is 1 mile from the point. At Ponta de Norte, 1½ mile; or a quarter of a mile, 12 fathoms; half a mile, 30 fathoms, three-quarters of a mile, 40 fathoms; 1 mile, 50 fathoms. Along the N.W side the bank is comparatively shallow and rocky, to the extent of half a mile from the land, where there are 15 fathoms, and the edge of the bank is 1¾ mile off. Off the South point it does not reach to 1 mile off.

A short distance to seaward of the rocks in front of the cliffs near the village, and with the church bearing N. 31° W., three-tenths of a mile distant, lie three patches of sunken rocks, on which are 3 and 4 fathoms water. They are steep-to. There are no dangerous rocks before the stony beach in front of the village, but the surf which usually plays upon it makes the cove to the westward of the mill a preferable landing-place.

The best anchorages at Corvo (mentioned by Tofiño) are on the westward side, between the parallels of the Ilheo de Mulher and the Sugar-loaf Rock;

30 to 35 fathoms, fine brown sand, about 1 mile off shore; and on the eastern side, in 25 to 30 fathoms, sandy bottom, about half a mile due East of Ponta de Casa. Capt. Vidal cannot advise the adoption of these anchorages, nor of any others the island may afford, except as a matter of necessity.

It has no fuel to spare, no facility for watering, nor, indeed, anything to offer which cannot be most abundantly and conveniently obtained at Flores; whilst from its size and form it affords little shelter from wind or sea.

The flood tide sets upon the island N. 30° E., and the ebb in the opposite direction, at an ordinary velocity, in springs, of 1½ mile per hour. When this is opposed by a gale it occasions a very high, confused sea, as it sweeps over the rocky, uneven bottom at the North and South points.

The bank of soundings around Corvo is nearly of a circular form, and extends with some regularity on the East side to the distance of 1 mile and a third; on the West side, a mile and two-thirds; the same to the North. It is narrowest to the South near Point Pesqueiro Alto, where it is only two-thirds of a mile.

To the eastward it is generally of sand, sometimes with coral, and rocky patches. To the West the prevalent bottom is also sand, with some gravel and rocks. A vessel should not anchor till she is assured beforehand of the quality of the ground and depth of the water, which increases regularly from the shore to 50 or 60 fathoms, and then suddenly falls to above 200 fathoms.

It is high water, on full and change days, at Flores and Corvo, at $12^h\ 20^m$, and the rise and fall is about 3½ ft. The tidal hour and range is nearly the same, or a quarter of an hour later at the other islands.

Flores and Corvo form a separate group from the rest, and the channel, 120 miles broad, has no known danger, and therefore is probably the best to use in passing through the archipelago. The current sometimes sets to the N.E. through this channel with varying strength according to the wind. But, as a general rule, the continuation of the drift from the Gulf Stream bears to the S.E. and South, rarely to the S.S.W. This is more usual to the North of the islands.

4.—THE ISLANDS OF MADEIRA AND PORTO SANTO.

PORTO SANTO, etc.—Ships are recommended to make, in the first instance, the Isle of Porto Santo, and thence proceed for the Road of Funchal, on the track shown upon the particular plan given in the Chart. The land of Porto Santo is very remarkable, and may be seen, in fine weather, 15 or 20 leagues off. It first appears in two or three very high hummocks, by which it is distinguished from Madeira, and the little isles named the *Desertas*.

It is said that it was discovered by two Spaniards in a voyage to explore the coast of Africa, but being driven off in a storm, they here found shelter, and named it, in consequence, Porto Santo. At present it is a dependency of Madeira, and its population, in 1877, amounted to 1,760 persons.

Porto Santo (*a*) *bearing South*, 14 *miles.*

It is 6⅜ miles in length from N.E. to S.W. Its mean breath is 2½ miles, and its circuit 17 miles. The surrounding bank of soundings is more considerable than has been supposed. The N.E. part consists of numerous rocky pointed mountains, some nearly 1,700 ft. in height, and all its North coast is generally high inaccessible cliffs, with detached rocks at their bases. The central part is much lower than the extremities, but the North and N.W. coasts rise to 700 ft.; from whence it slopes to the South, and terminates in a beautiful white sandy beach, which forms its entire S.E. shore. On this central part are several sandfields, covered with what appear to be fossil heath stems, probably coral formation. The S.W. end of the island is also rocky and elevated, some of the hills exceeding 900 ft. in height. The town, *Villa Baleira*, is situated near the centre of the bay on the S.E. side, about 300 yards from the beach. The church and court-house on it are conspicuous; and a little to the West of them is a small battery, in lat. 33° 3′ 30″ N., long. 16° 20′ 14″ W.

The Pico de Castello, 1,447 ft. high, is N. 4½° E. from the church; and on its summit are the ruins of several water tanks and stone buildings. The two peaks immediately to the East, called Fachio and Guadaya, are the highest in the island, the former being 1,600 ft. high.

The island is chiefly used for pasture, cultivation extending along the shore of the bay and the low land. The island suffers grievously for the want of water, but produces wine, grain, and vegetables; also plenty of live stock and poultry. The banks around abound with fish.

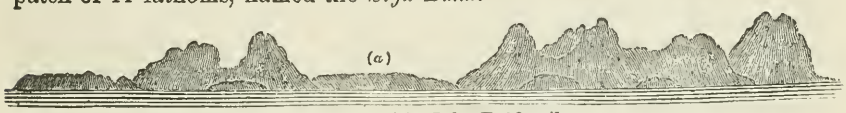
The landing at Porto Santo is usually made upon the beach in front of the town, though there are no artificial facilities for so doing. It is high water, at full and change, at $12^h\ 50^m$; the rise of the tide is 7 ft. Generally, vessels should not anchor in the bay within the line joining the South extreme of Ilheo Baixo and the low extreme of Ponta de Incao, bearing S. 49½° W., and N. 49½° E., and the South point of Ilheo de Cima N. 73° E., 2 miles distant In this position, which is 1⅓ miles from the landing-place, there will be 17 fathoms water, over a bottom of small gravel and broken shells. The edge of the bank is rather less than half a mile to the South of it; the depth of water increasing rapidly. During the settled weather in summer vessels may anchor near the shore, but care should be taken not to be caught in the bay. In the present condition of the island it is of little service to navigation, as Madeira itself offers superior advantages.

Ponta de Incao, the S.E. point, is composed of high rocky cliffs. Off it lies the *Ilheo de Cima*, a table-topped island, 360 ft. high. There is a boat passage inside it. Off it is a good fishing station. *Ponta dos Frades*, a bold point, steep-to, is 1 mile N. by E. from Ponta de Incao, and between them

is the small sandy bay of Ponta dos Frades. *Ponta Branca*, the N.E. point of the island, is composed of three bluffs, the northern one of which forms a fine, bold promontory, the peak of which is 1,390 ft. high. Three rocky islets, steep-to, with navigable channels between, lie off the Ponta Branca. The outer, or *N.E. Rock*, is 330 ft. high; the rocky bank, on which they stand, has a patch of 10 fathoms at $2\frac{1}{2}$ miles N. 32° W. from the N.E. rock.

Off the S.W. point is *Ilheo de Ferro*, 380 ft. above the sea, almost inaccessible, and having a narrow but safe channel inside it. *Baixo Island*, off the South point, *Ponta de Calheta*, is $1\frac{1}{2}$ mile in length, and is only visited for its limestone quarries, a singular feature. They are national property.

Off the N.W. coast of Porto Santo the bank of soundings extend for 8 miles, with a general depth of from 25 to 35 fathoms, fine white sand. Near its N.E. margin is the Falcon Rock, the position of which was first ascertained by the officers of H.M.S. *Falcon*, Lieutenant J. Bowen, in January, 1802. It is a mere knoll, on which there are $4\frac{1}{2}$ fathoms at low water. It is said to break at times. When on the rock the highest land of the N.E. rock bears S. 60° E. $6\frac{1}{4}$ miles; of Ilheo de Fonte, S. 13° 10′ E. $4\frac{5}{8}$ miles; and of Ilheo de Ferro, S. 5° 30′ W. $8\frac{3}{4}$ miles. Vessels coming from the N.E., with a fair wind, may pass it, keeping the Ilheo de Fonte (off the middle of the North coast) in line with the high land at the S.W. end of Porto Santo. At nine-tenths of a mile N. 37° W. from Falcon Rock is a shoal patch of 11 fathoms, named the *Styx Bank*.



Porto Santo (*a*) *N. by E.* 12 *miles.*

DESERTAS.—To the S.E. of Madeira, the Desertas, a line of narrow rocky islets, extend nearly in a North and South direction by compass, the North extremity of which bears S. 34° 8′ E. 10 miles distant from its East point. Between them in this space is a bank of soundings of from 45 to 75 fathoms, about 2 miles broad, on which, in settled weather, fishing-boats frequently anchor. This bank continues quite round the Desertas.

Chao, the northernmost, is nine-tenths of a mile in length, and one-quarter of a mile in width at the North end. It is tabled land; the highest point to the North is 336 ft., and is surrounded by high rocky cliffs. Off the bold bluff at the North extreme is a remarkable detached rock, called by the Portuguese the *Furrilhao*, but known to navigators as the *Sail Rock*. It lies due North of the point, 100 yards distant, and is 160 ft. high. At 300 yards N. 65° W. from it is a breaking rock, and a narrow ridge of irregular soundings extends from it N. 30° W. nine-tenths of a mile. The surface of Chao is composed of light soil, with rocks and stones, covered with long coarse grass, and a few aromatic herbs. Near its centre is a pond of turbid water. The highest land is near the North point, and is 336 ft. in height.

The *Deserta Grande* is the largest and most elevated of the three islands. It is $6\frac{1}{2}$ miles in length by 1 broad at the widest part. From *Ponta de Pedregal*, on the West side, to its South extreme, it consists of a continuous chain of rocky heights, the highest peak of which, 1,610 ft., lies $1\frac{1}{8}$ mile *E.S.E.* of the point. The width of the passage between Chao and

the North point of Deserta Grande is but little more than 300 yards between the rocks, and this is further contracted by a breaking rock in the centre, so that it is only practicable for boats in fine weather. Ponta de Pedregal is 2 miles from the North end. It is a detached rock, with high land towering above it to more than 1,200 ft. in height. Between this point and the next to it to the North is the little cove of *Castanheira*, where there is a boat landing-place, marked by a detached rock. *Ponta de Boqueirao*, the South point, is 4½ miles *S.* 30° *E.* from Pedregal, with a rock close to it, but the point is steep-to and clear. The East coast is a rugged, broken, irregular line of cliffs. Northward of Point Pedregal the island is differently formed to what it is southward, consisting here of two ridges, with a ravine between them. At the head of this valley or ravine, at the foot of a green hill near the centre of the island, about East of Pta. Pedregal, is a small house, and near it two ponds or reservoirs of turbid water; and a few yards down the valley is a delicious spring, though yielding but a limited supply.

The *Bugio*, or *South Deserta*, is about 4½ miles in length. Its greatest breadth is not half a mile. The passage to the North of it is two-thirds of a mile in width, and is perfectly clear; depth 19 to 20 fathoms, and 7 fathoms within 30 yards of either point. Both shores are rocky cliffs, of less altitude than the Deserta Grande, surmounted by a very sharp serrated rocky ridge of hills, which runs the whole length of the island. There is a gap in this ridge, near the centre of it, which at a distance gives it the appearance of two islands. The highest peak on the North part is 1,349 ft., and on the southern part 1,070 ft. in height. *Ponta d'Agalha*, the South extreme, has a few rocks quite close to it, but 5 fathoms at 130 yards off. It is in lat. 32° 23′ 15″ N., and long. 16° 27′ 37″ W.

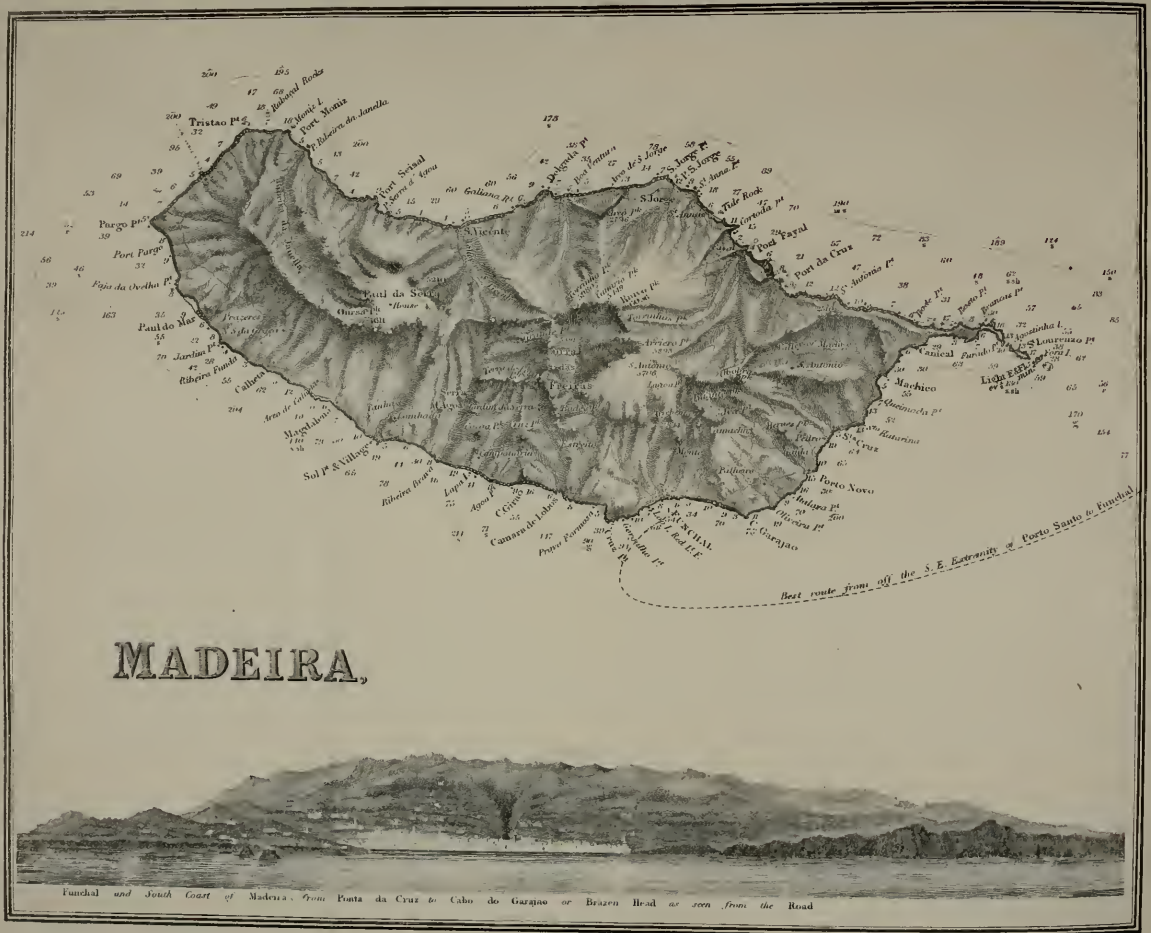
The bank of soundings round these singular islands is tolerably regular, extending 1½ mile from the East side, and 2 miles on the West side; and in a narrow ridge to Madeira as before mentioned.

The islands have no permanent inhabitants. They are frequented for orchilla; and on the centre one some cattle and sheep are pastured, and attended by a few casual visitors.

There is much danger to vessels passing close under the lee of these islands with strong breezes, in the violence of the gusts from the high land, which are most variable, both in direction and strength. It is no uncommon thing to see the water whirled into the air, and then precipitated on the vessel's masts and decks.

The tide sets by these islands at springs at the rate of 1½ to 2 miles per hour. The flood *N.* 31° *E.*, and the ebb *S.* 31° *W.*, and its rise is 7 ft.

MADEIRA.—The date and manner of the discovery of this beautiful island are involved in some obscurity. The most probable is the romantic tale of an Englishman of good family, named Robert Machim and Anna D'Arfet, two lovers, who, fleeing from the wrath of the lady's friends to the shores of France, were driven by a storm far away to sea, and at length met with this unknown and uninhabited island. Here they landed, and both died, the crew again departing. There are some variations in this story, both in date and particulars, but about 1344 is mentioned as the time. There is great probability of its accuracy; and in the present little church



MADEIRA.

Funchal and South Coast of Madeira. From Ponta da Cruz to Cabo do Garajao or Brazen Head as seen from the Road

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of Machico is said to be preserved a portion of the cross found over their graves, on the re-discovery between 1417 and 1419. This lattery discovery arose from the circumstance of a dark cloud being constantly seen in the S.W. by the settlers at Porto Santo, who had gone from Spain to the conquest of the Canaries. They sailed towards it, and on June 1, 1419, they discovered the point now called, after their vessel, Cape San Lourenzo.

Madeira is of volcanic origin, though the only sign of a crater is upon San Antonia (5,076 ft.), near Machico, at the East end of the island. It is a collection of mountains, the highest of which, the *Pico Ruivo*, is near its centre, and is 6,056 ft. high. To the West of it the ridge of the *Lomba Grande*, nearly of equal elevation, extends for 2½ miles, and forms the North edge of the stupendous ravine of the *Curral*, one of the wonders of Madeira. The western side of this is formed by a ridge of which the rocky summit of the *Pico Grande* is 5,391 ft. high. South of Ruivo is a ridge of peaks of nearly equal elevation, amongst which the three remarkable peaks of the *Torrinhas* are 5,980 ft. high. South of these, three-quarters of a mile, is *Pico Sidrao*, and half a mile farther S.E. is *Pico Arriero*, 5,893 ft. high. These may be considered to form the axis of the island, from which the mountains generally slope gradually to the South coast, and on the North, with few exceptions, they drop precipitously on to the bold high coast.

The cultivation is confined to the coast, or to the bottoms of some of the valleys, and occupies altogether a very small proportion of the surface. Vines form the chief feature; for the corn grown annually scarcely supplies a two months' consumption to the inhabitants.

In the year 1809, 15,363 pipes of Madeira wine were exported from this island by British ships. In the year 1851 the shipments to all countries were reduced to about 7,000 pipes, after which time, in consequence of the failure of successive vintages, the wine trade gradually dwindled away till the year 1861, when the annual export was reduced to about 360 pipes. With the renewal of the Madeira vineyards, the export trade of the wine has been steadily increasing since the year 1861, and in the year 1871 the export to all countries, but chiefly to Great Britain, amounted to 1,760 pipes.

In the island may be found almost every European and tropical luxury. The myrtle, the geranium, the rose, and the violet, may be seen on every side. The geranium, in particular, is so common, that the honey of the bees is strongly impregnated with its odour.

With the general increase of steam-navigation the consequent resort of shipping to the port of Funchal for coaling purposes has steadily increased, and the British coal trade has become important, as shown by the increase of British shipping entering the port of Funchal since the year 1851, viz.—In 1851, 112 British vessels measuring 28,959 tons; in 1871, 340 British vessels measuring 202,480 tons; in 1876, 424 British vessels measuring 371,876 tons, and foreign 182 vessels, of 77,620 tons.

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* The distance to which the mountains of Madeira ought to be seen from a vessel's deck is about 90 miles; but of course, at this low elevation, it would require a very clear atmosphere. Sir Andrew Lang says, that on leaving Madeira for the West Indies, December 26th, 1822, the Pico Ruivo was distinctly visible when the ship had reached 75 sea miles from the anchorage at Funchal, bearing N. 40° E., at 2½h p.m.; lost sight of it soon afterwards, from the thickening atmosphere.

The population of Madeira at the time of the census in December, 1876, numbered 122,081.

Winds.—The N.E. trade-wind sets in about the middle of April, and continues until the end of September.

Gales are principally to be apprehended in November and December, commencing a few points on either side of South, gradually veering round to the westward, and terminating in the N.W.

In the winter months eddy-winds and squalls, proceeding from the high land, are frequent and severe, and the ships are often forced to put to sea from the road. Severe westerly and S.W. gales, with rain, then frequently prevail, and prevent regaining it for some time. At these periods, Madeira and the Desertas are often obscured in fog. The squalls have been found so sudden and violent near the Desertas and about the S.E. end of Madeira, as nearly to overset the ships in the vicinity; and many have been driven by them far to the eastward.

At Madeira is a wind called the *Leste*, which occurs in August and part of September, which, as its name implies, comes from the East, although all East winds are by no means *Lestes*. It appears to be of the same kind as the *Harmattan* of Western Africa, and is of a hot, close, drying nature, particularly oppressive to some constitutions, which it affects by languor, headache, and a parching of the skin and lips. What is remarkable, the residents are those whom it most disorders in this way. Visitors in general suffer much less; and the invalids are never so well as while it lasts. A peculiar clearness and cloudlessness in the atmosphere are among the invariable indications of Leste, and the weather during its continuance is most delightful; the sky of a deep blue, so stainless that one might fancy it had never been sullied by a cloud; with a transparency in the atmosphere, which, like the effect of moisture, seems to bring out fresh hues from every object.

At times, but not frequently, the Leste is accompanied by a strong wind, but the weather is still delightfully warm and pleasant. The nights, too, are delicious—soft and balmy; and with the moon shining in summer brightness, and the orange trees in flower, the air is loaded with perfume. With the departure of the Leste, rain almost invariably follows.

The climate, generally, is delicious, and strikes with peculiar charm to a stranger, whom a short sail has transferred to it from the very midst of the gloom and chill of an English December. Indeed, the great natural distinction of Madeira is the climate, which, perhaps, taken altogether, is the finest in the world.*

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* The mean temperature, from observations during eighteen years, has been given as follows:—January, 64°.18; Feb., 64°.3; March, 65°.8; April, 65°.5; May, 65°.53; June, 69°.74; July, 73°.45; Aug., 75°.2; Sep., 75°.76; Oct., 72°.5; Nov., 69°.8; Dec., 65°. The year is, therefore, one summer, with comparatively little alteration, either of temperature or hue.

"In fine weather—and it is fine at Madeira nine months in the year—the view of this steep and lofty island, covered with bright verdure, and enlivened by numerous scattered houses, as white as snow, is very striking to a stranger who arrives from the low and tame-looking shores of the South coast of England.

"Seamen are often deceived, when about to anchor in Funchal Roads, in consequence

Water, of excellent quality, is abundant. Springs are found everywhere, and copious; even the streams at the bottom of the ravines, fed by the mountain mists, are never dry in the hottest season; and the height from which they descend enables the inhabitants to divert the course of the water at any elevation or in any direction; the whole cultivated region, therefore, is irrigated on all sides by these *levadas*, or water-courses. On the coast fish is abundant, and forms an important article in the food of all classes.

The towns and villages are invariably situated on the sea-coast, and commonly at the outlet of a ravine; but where the bottom is fertile, and the surface permits, the cabins and *quintas*, or country seats, are often scattered up a considerable extent of the valley.

The *Corral* or *Curral* of Madeira, a few miles north-westward from Funchal, is one of the grandest scenes in the world. Admiral W. F. Owen says, that the *Curral* means simply a sheepfold, and is an immense valley, completely surrounded by hills, whose sides are literally perpendicular, in no part being less than 1,000 feet high. Round a part of these cliffs is a narrow road leading to the garden houses and country plantations, cut out of the rock, about 10 or 12 ft. wide. On riding along the road over the Curral, it seems like an unfathomable abyss, filled only by clouds and vapours rolling in a constant motion over each other.

"*The money* current in Madeira is chiefly Spanish, English, and American; Portuguese coin being represented by copper money only. The computation is decimal in character, the unit *reis* existing hypothetically as one-fifth of a farthing." * The Portuguese coins (copper) are as follows—*cinco-reis*=one farthing, *dez-reis* = one halfpenny, *vintem* = one penny.

The extreme length of the island is $31\frac{3}{4}$ miles, its greatest breadth 12 miles, and the circuit along the line of coast 79 miles.

High water, full and change, $12^h\ 48^m$; rise 7 ft; the flood runs *N.* 30° *E.* at $1\frac{1}{2}$ mile per hour on springs.

ST. LOURENZO POINT and Lighthouse.—On Fora Island, 340 ft. high, the outermost island off St. Lourenzo Point, which is the easternmost point of Madeira, stands an octagonal lighthouse, 41 ft. high, showing a *fixed light*, with a *flash every half minute*, at an elevation of 343 ft. The light is visible, in clear weather, 25 miles. The position of this lighthouse is lat. 32° 43′ 14″ N., long. 16° 39′ 30″ W.

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of the sudden transition which they have probably made from a low shelving coast to an abrupt and high mountain side; for the bottom of the anchorage slopes away suddenly as the heights overlooking it, and the anchor must, indeed, be let go upon the side of a mountain. Hence ships seldom go close enough, unless guided by a person who knows the place; and many a chain cable ran out to the clinch, when chains were first used, owing to an incorrect estimate of the vessel's distance from shore, and not taking time to sound accurately.

"Closing the land quickly, after passing some time at sea—approaching high cliffs or hilly shores, after being for a time accustomed to low coasts—or nearing a flat shore, after the eye has been used to precipices and mountains—almost always is a cause of error in estimating distance, however experienced a seaman may be."—*Captain FitzRoy*, vol. ii., p. 46.

* The Climate and Resources of Madeira, by M. C. Graham, M.D., F.R.G.S. London, 1870.

Fora Islet is separated from San Lourenzo Point by a channel 200 yards wide, the depth in it at low water being from 3 to 4 fathoms, rocky bottom; but a swell or strong breeze with opposing tide causes so great a turmoil in it, that it is frequently unsafe for boats to pass through.

The islet is steep to in all directions, except its S.E. side, off which are dangerous rocky patches surrounded by deep water. The outer one, which lies S.E. nearly 4 cables from the islet peak, is a small rock with 4 fathoms on it and 13 and 26 fathoms close to it. The inner patch is more extensive, bearing from the peak S.E. by S. 3 cables; and upon this are several rocks, some with 15, others with only 4 ft. over them.

Ponta Furada is a bold basaltic point, surmounted by a hill 550 ft. high, and through it is a fine lofty arch, made by the waves. Half a mile West of it is *Ponta de Piedade*, crowned by a rocky hill, surmounted by a small but very conspicuous white chapel. North of this, quite across the narrow neck which forms the East extreme of Madeira, occur those curious fields of fossils, similar to those described at Porto Santo. *Canical Point* and village are 1⅓ mile W. by S. of this, the coast being lower. To the S.W. of it the cliffs are bold and high, as far as *Machico Bay*, 1¾ mile S.W. of Caniçal.

Machico Bay is a most romantic spot, celebrated in tradition as the place where the first discoverer, Robert Machim, landed with Anna D'Arfet. The village church is supposed to cover their graves. The village has a considerable number of fishing boats. Between Machico and *Ponta Queimada* the distance is half a mile, and thence to *Ponta de Santa Catarina* 1¼ mile; off the latter is a steep rock, but the whole coast is bold, and no outlying dangers. *Ponta Guindante* is the next projection; between them there is a bay, at the North end of which is the valley of *Santa Cruz*. Close around Guindante, the S.W., is the village of *Porto Novo*, in a small shingle bay, where a considerable ribeira has its outlet.

Atalaya Point is nine-tenths of a mile *S.* 40° *W.* of Pta. Guindante, and has a singular small pointed peak on the cliff, close to it. From this *Ponta Oliveira* bears *S.* 51° *W.* 1 mile; it is a clean rocky point, steep-to, upon which you can land, and the ascent from it is easy.

Cabo Garajo, the *Brazen Head*, the East point of the Bay of Funchal, is 12 miles W. by. S. from Fora. It is a bold rocky headland, jutting out at right angles to the line of coast. It is formed by perpendicular cliffs of reddish-yellow tufa, and above them is a narrow hilly ridge of land, crowned with a rocky knob or knoll, 420 ft. above the sea, on which is a *Telegraph Station*, from which all vessels are reported to the station on the Loo Rock. This knoll particularly distinguishes the head when seen from the westward. The cape is steep-to.

THE BAY OF FUNCHAL is bounded to the East by the Brazen Head, and on the West by *Ponta da Cruz*, bearing from it *S.* 87° 40′ *W.*, distant 5 miles. The coast to the West of Cape Garajo is a series of rocky cliffs and small stony points to Santiago Fort, which is exactly midway between the two extremes of the bay. It is also at the East end of the town of Funchal.

FUNCHAL, the capital of Madeira, was named thus by Gonçalves Zarco, on July 3rd, 1419, when first landed on, from the quantities of fennel growing here.

"The resort of steamships to the port of Funchal for coaling purposes, continues to increase, and the demand for the supply of beef, poultry, vegetables, and other island productions taken by shipping (which exports are overlooked in custom-house returns of trade) continues to enhance the price of provisions. The same cause is contributing to raise the wages of labourers and servants, and to increase the expense of living in Madeira."—Mr. Consul Hayward, April, 1874.

The *Electric Telegraph Cable*, during the year 1874, was established between Madeira, Lisbon, St. Vincent, Cape Verdes, and Brazil.

The number of vessels visiting Funchal Roads during a year is about 600. By a decree dated 27th December, 1870, the tonnage dues payable in Portuguese ports have, with some very small exceptions, been levied at the port of Funchal. One ton register is reckoned as 1,133 metres.

"Funchal," says Captain Wilkes, "has a very pleasing appearance from the sea, and its situation, in a kind of amphitheatre formed by the mountains, adds to its beauty. The contrast of the white buildings and villas with the green mountains forms a picture, which is much heightened by the bold quadrangular Loo Rock, with its embattled summit, commanding the harbour in the foreground.

The town of Funchal stretches along the margin of the bay for nearly a mile. The cathedral is a fine building: before its western edge is a *parvis* or open space, and beyond that the *Terreiro da Se*, a very pleasant promenade, under four or five parallel rows of trees, and enclosed by a wall, a few feet in height. The church of *Nossa Senhora do Monte* is the neatest in the island. It is seated on a terrace just half-way up the mountain, and commands one of the most enchanting views in the world. The city of Funchal had a population of 16,776 persons in 1877.

Directions.—Madeira is often so entirely clouded over, as not to be visible at the distance of 5 leagues. But when abreast of Porto Santo, the island commonly appears as one great mountain, with its summit hidden in the clouds. Shortly after appear the Desertas. Having passed those islands, you will soon perceive the ships in the Road of Funchal; and from their riding, it will be seen how the wind is in the road, as it is common to have a strong breeze from the N.E. or East, on passing the Desertas, when, at the same time, the wind in the road is from the S.W. or W.S.W.

When sailing in toward *Funchal Road*, a large rock, named the Loo Rock, with a fort on it, will be seen on the west side of the road, a little to the westward of the town. A *red fixed light* is shown from an iron column on the fort, at 112 feet, seen 8 miles off. With this rock or the *red light*, N. by E., when in 38 or 36 fathoms, let go the port anchor with two cables on it, for should there be a fresh breeze from the eastward it will be scarcely possible to bring up, until the splice is veered a good way out. It is requisite to ride in the road with a whole cable, and with a splice so situated that you may be able to cut near it, should circumstances unfortunately compel you to put to sea without weighing anchor. While riding, keep a slip-buoy on the cable, have a kedge anchor and a 9-inch hawser to the westward, to keep the ship steady, with the hawser on the starboard bow, as the wind generally veers from the eastward to S.W. and

West. When the land wind makes a cross, the end of the hawser may be shifted.

The general anchorage is from 30 to 35 fathoms, with the citadel (called the *Peak Castle*, a brown square fort on a hill over the N.W. part of the town) a little open to the eastward of the Loo Rock; the latter at the distance of half a mile.

With the Loo Rock and citadel in one, bearing nearly N.N.E. ¼ E., and Funchal Steeple N.E. ¼ N., the anchorage appears equally good, in 35 fathoms, stiff ground. With the same marks, with the Loo about a mile off, there is good ground in 45 fathoms. To the westward the ground changes to sand and rock, and to the eastward it has a sudden declivity from 50 to 55 fathoms, stiff clay ground, to 100 fathoms, rock, and then no ground. A red *wreck buoy* was placed 3½ cables S. ¼ W. from the East end of the Loo Rock in 1871, and this position should be avoided, as the buoy sometimes shifts.

In case of a S.W. gale, which may be frequently expected in winter, the situation with the Loo and citadel in one, or the citadel just open to the westward of the Loo, will be found most convenient. On the contrary, the citadel, well open to the eastward of the Loo is the best situation when a south-easter may be expected.

The *Pontinha* is an artificial embankment carried out in a south-easterly direction, from the land to a small islet, which is crowned by the fort of San Jose. The work affords some shelter from S.W. winds, and on its eastern side is the most convenient landing place, there being on the inner side of the islet a flight of steps which lead from the sea to the fort, and to the top of the embankment, which joins the road to the city.

When coming into the road, with a brisk wind, sail should be reduced and secured in time, to prevent having too much way through the water, at the moment of anchoring; and ships should be brought up with their head to eaward; for thus, in case of any accident in bringing up, sails may be had off shore, or otherwise, as required.

Those riding in *Funchal Roads* should be very active when they observe a swell coming in from the S.W. or S.E.; at this moment, no time is to be lost in getting under way, for the swell indicates that a gale is certainly coming on; particularly so in the months of December and January, generally the commencement of the rainy season. Should it come on to blow very hard from the westward, the best mode is to run to leeward of Desertas, where shelter from the wind may be found, and water perfectly smooth; thus you avoid the risk of losing sails, by heaving to windward.

Admiral FitzRoy says:—The roadstead of Funchal is well-known to be unsafe in S.W. gales; and there can be no doubt that the most prudent plan is to keep at sea while they last; but I have been told by old traders to Madeira, that ships sometimes remain at anchor, about half a mile from the Loo Rock, and ride out S.W. gales without difficulty; the under-tow being so considerable, that their cables are little strained."—Vol. ii. p. 46.

These statements require some modification. On October 15th, 1842, Madeira was visited by one of the most dreadful storms that had occurred since the flood of 1803, which swept 400 persons into the sea. On the 25th

it blew a tremendous hurricane from the South, which, with the terrible sea, drove four out of the six vessels on shore, with total destruction, aad nearly all the crews were lost.

Steam vessels, that are prepared to weigh at short notice, anchor off the city in less than 10 fathoms, and the Cape mail packets anchor inside the Loo Rock in 3½ to 4½ fathoms.

For coaling from beach store, vessels should anchor ¼ of a mile off shore, in 14 fathoms, mud, Loo Rock W. by N. ½ N., Church Tower N. by E. ½ E.; if to coal from colliers, a short distance to leeward of them. A white flag with St. George's cross indicates the coal store on the beach. The flag is always hoisted over the coal store, adjoining Bangers pillar, when coaling from the beach is practicable.

A weft hoisted at the fore indicates an order to send off coals. This, when shown by steamers in sight of the port, will bring coals alongside as soon as they anchor.

When bound into Funchal Road from the Eastward, the best way for ships, however large and numerous, with the wind north-easterly, is through the passage between the Desertas and Madeira. The north-easter will carry them to the offing of the Brazen Head, the East point of the Bay of Funchal. In the night, a single ship may keep over toward that bluff point, and, with her boats towing ahead, when becalmed, luff up into the stream of the land-wind, and by that means fetch the anchorage. Ships must show a light at their ensign-staff in the night, to prevent being fired at from the forts at Loo Castle. In the day, they should keep further distant from the land than in the night, to avoid being becalmed under it, and to gain the stream of the sea-breeze. If, from over-caution, or other reasons, they fall 2 or 3 leagues to the leeward of the road, they should then keep plying up in the stream of the valley, until they gain the vein of the sea-breeze. In working in with a land-breeze, it is best to make short tacks, opposite the valley; as here both the land and sea-breezes are most regular.

Small vessels, from North America and the Western Islands, come in, generally, round the West end of the island, but are frequently becalmed a considerable time under the high land there. For this reason ships, on leaving Funchal, should make sail with the land-wind, and stand directly off from the road; ships bound to the southward, by taking a contrary method, having continued several days becalmed under the western part of the island.

From the Pontinha to *Ponta da Cruz*, the distance is 1½ miles; the coast between has a broken outline of rocky cliffs, points, and bays. The bay to the West of the Pontinha is half a mile across, and its shores are composed of steep cliffs, with a high bold bluff at its west extreme. Along the base is a beach of sand extending as far as the watercourse. The whole of the bay is comparatively shallow, and appears to offer the best position in Madeira for any artificial harbour works.

The *Gorgulho*, a detached sugar-loaf formed rock, lies off a pretty little bay, half a mile West of this. Four-tenths of a mile North of this rock is *Monte de Cruz*, 862 feet high, with a telegraph on its summit, and hence there is a succession of rocky cliffs for another half mile to *Ponta da Cruz*,

at the S.W. extremity of which there is a semi-detached pointed rock with a small iron cross on the top of it. This rock is the South extremity of Madeira, and is in lat. 32° 17′ 18″ N., long. 16° 57′ 11″ W.

Immediately to the West of Ponta da Cruz is the little bay of *Praya Formosa*, formed by a shingle beach; and at 1½ miles from it is the mouth of the *Socorridos River*, a mountain stream, perhaps the largest in Madeira, which drains the celebrated valley of the Curral. At the West side of the mouth of this is a small bold rocky part, round which are the village and little boat harbour of *Camera de Lobos*. The West side of this is a narrow wavy line of black lava, running out South at 270 yards. The little town is old and poor enough, but the sides of the mountains around are covered with quintas and vineyards, and are said to form one of the finest wine districts of the island.

CAPE GIRAO, a magnificent headland, is five miles West of Funchal. It is the termination of a ridge of mountains lying westward of the valley of the *Jardim da Serra*. The cape is nearly perpendicular for 1,600 feet above the sea, which nearly washes its base; and upon the high land which covers it is a grove of pine trees, 2,079 feet above the sea. The hills continue rising until they reach the head of the valley, at an elevation of 4,535 feet.

At 2 miles from Cape Girao is the *Ilheo de Lapa*, a conical-shaped rock, in front of the village of Campanaris. The coast to the East has a continuous line of stony beach; towards the West this characteristic alternates with *clean* black rocky points.

Ponta do Sol is 5½ miles W.N.W. of Cape Girao. It is a bluff rocky cliff, with some fragments of rock lying close in front of it; the largest of these is pointed, and has a small wooden cross on it. The Ponta do Sol in a westerly gale and stormy weather appears surrounded with the colours of the rainbow, arising doubtless from the spray of the surf; hence, probably, its name has been derived. The village of Ponta do Sol is up the ravine to the West of the point; its church may be seen through the narrow gorge. Westward of this the coast is a long wavy line of narrow stony beaches, above which are cliffs of small elevation, much broken by ravines and landslips; one remarkable piece of cliff stands 1¼ miles West of Ponta do Sol. Three-fourths of a mile beyond this is the village of Magdalena, at the outlet of a ribeira; 2 miles beyond Magdalena is another ribeira; the space between is called the *Arco da Calheta*. At 5 miles from Ponta do Sol is the town of *Calheta*, but little can be seen of it through the very narrow ravine. At a quarter of a mile West of it, above the cliffs, on a ridge of land, is a conspicuous long building like a monastery. *Ponta Galera* is seven-tenths of a mile from Calheta; it is a natural jetty of flat rocks of black basalt, 100 yards long.

Ponta Jardim is 1½ mile *N.W. by W.* of Ponta Galera; it appears to be a landslip; upon the top of it are a small village and a chapel. The soundings off this part of the coast are regular, over dark sand, and extend off 1⅓ mile, with 30 fathoms 1 mile off. *Paul do Mar*, a village on the coast, is 1 mile from Ponta Jardim. There is a waterfall here, and a great land-slip. The land is cultivated in terraced vineyards. A grove of pines above Paul

do Mar is 2,030 ft. (or one-third of a mile) above the sea, while its horizontal distance from it does not exceed half a mile. This will give an idea of the bold character of the scenery.

The beach of shingle and large stones extends 1 7-10ths miles to *Point Fajao d' Ovelha*. Here it is broken through by a little spur of black lava; the cliffs become more elevated, and above them the land rises with a steep ascent to the highest peaks of the western mountains, 4,270 ft.

Ponta Parga is the western extremity of Madeira, and is $2\frac{2}{3}$ miles W.N.W. of Ponta Fajao d'Ovelha. The bold rocky cliffs of the point are 935 ft. high, and the smooth-topped hill to the East is 1,380 ft. On the heights, 1 mile East of the point, there is a church. Some rocks and large stones lie scattered around the base of Ponta Parga, and a rocky ridge of 11 to 20 fathoms runs off it $1\frac{1}{2}$ mile, and occasions a heavy sea in westerly winds. Ponta Parga is in lat. 32° 48′ 6″ N., long. 17° 16′ 38″ W.

The bank of soundings extends $5\frac{1}{4}$ miles West of Fajao d'Ovelha Point; to the N.W. of Ponta Parga its breadth is $2\frac{3}{4}$ miles. It is flat, with 40 to 46 fathoms, light brown or dark gray sand, and occasionally rock. From these depths it drops very suddenly to 200 fathoms.

Ponta Tristao is the next point, N.E. of Ponta Parga, bearing *N.E.* 5 miles. The coast between it is a wavy line of coarse stony beach, with high rocky cliffs rising abruptly from it. Above the cliffs the land rises steeply to the ridge of mountains above 4,000 ft. high, and 2 miles from the shore. Ponta Tristao, the North point of Madeira, is a high, bold bluff, 1,070 feet high, off the foot of which are a few sunken rocks, extending 130 yards, but clear beyond. On the heights, 1 mile to the South, is the parish church of Magdalena, 1,700 ft. above the sea. At nine-tenths of a mile *N.* 60° *E.* from the point, and about half a mile from the adjacent beach, is a singular cluster of flat rocks, a few feet above the sea, called the *Rochas de Rabacal*. With any sea, the surf rolls over them, but they are steep-to, and a deep channel inside them.

Ponta Moniz is $1\frac{1}{2}$ mile from Ponta Tristao, and is formed by a mass of lava running out N.E. about 470 yards beyond the general line of coast, and looks as if it had flowed over and beyond the cliffs into the sea. The shores of the point have a very irregular and broken outline. On either side of it are detached rocks, and right off the bluff are four others in a straight line. On the East side of the point is a small fort with a round tower; and 140 yards S.W. of the outer islet off the point is another rocky point and another round tower, at which is the best landing as at a jetty. The town of *Moniz* is on the higher part of the point; the chapel being one-third of a mile from the landing-place. The whole point is cultivated with vines. In front of the point, at the distance of 120 yards, is an islet of the same name, composed of yellow tufa resting on black lava. Its shores are precipitous, and it is the resort of sea-fowl. It has no channel inside it. The little bay, locally called *Porto Moniz*, is in fact a rocky bank, varying in depth from 2 to 40 fathoms.

One mile *S.* 42° *E.* from Ponta Moniz are a group of rocks, called the *Janellas*, lying near the outlet of that ribeira. They are five in number, the largest 133 feet in height. At $2\frac{2}{3}$ miles *S.* 52° *E.* from the outer Janella is the point and village of *Sicsal*. The point is a comparatively low, rocky,

projecting piece of land, with a great variety of feature. The town stands on the top of the point, a short distance from the cliffs, and surrounded by vineyards. The best landing is on the largest rock at the East extremity of the point, which is on this account connected with the shore by a wooden bridge.

San Vincente is 3¼ miles from Ponta Siecal. The outlet of the ribeira is marked by an isolated sugar-loaf rock, standing a few yards within the beach. This rock has been excavated and converted into a chapel. *Ponta Delgada* is 3¼ miles from San Vincente, the coast between lying generally similar to that West of the latter, a piece of low land at the foot of the mountains, with houses and cultivated enclosures. Ponta Delgada is a comparatively low point, composed of rocky cliffs, with a tower upon the top of it. The houses, which are numerous, and many of them pleasing and respectable, are scattered thickly among the richly cultivated vines and orchards, with a very pleasing effect. The church, large and handsome, is close to the sea. Close round the point, on its East side, is a small bay, with a little bit of fine shingle on it, which offers the best landing.

Ponta do Arco, a bold black point, is 1 2-5th miles East of Ponta Delgada. Nearly midway are a few large detached rocks, the largest called *Rocha de Boa Ventura*. A group of low rocks lie off 230 yards to the W.N.W. of it, and abreast of it are two *ribeiras*, the larger named *Entroza*. Nearly three-quarters of a mile inland from Ponta do Arco is a conspicuous sharp, wooded peak, 2,746 ft. high, the summit of the Arco de San Jorge, a valuable station on the survey from its unmistakeable peculiarity of feature.

Ponta de San Jorge is in lat. 32° 19′ 44″ N., long. 16° 54′ 47″ W. It is a high, bold, rocky bluff, nearly 700 ft. above the sea, and may be called the N.E. point of the island. A small low rock just seen above water, on which the sea commonly breaks, lies *E.* ½ *S.* three-tenths of a mile from Ponta San Jorge. The next point to the S.E. is *Santa Anna*, bearing *S.* 59° *E.*, distant 1 1-10th miles. On the same bearing is a large isolated rock, *Ilheo de San Jorge*, 134 ft. in height, one-third of a mile from Santa Anna Point. The point is formed by a gradually rounding narrow beach of large stones and coarse shingle, from which the land rises very abruptly. One-fourth of a mile from the sea it attains an elevation of 1,100 ft. The country above the sea-face is well wooded and extremely beautiful; and the quintas spread over it are amongst the most favourite summer retreats of this island. A detached rock lies a quarter of a mile S.E. of the point, and is about 12 or 14 ft. high. At 1 1-5th mile from this point, and 400 yards off shore, is a small isolated rock, which uncovers at low water.

Ponta Cortada, a remarkable point, is 1 9-10th miles *S.* 52° *E.* from Ponta de Santa Anna; at 6-10ths of a mile to the N.W. of it there is a singular sharp peak, 1,730 ft. high, standing close to the edge of the cliff overlooking a large high mass of rock at its base, called the *Rocha do Navio*. Ponta Cortada has a very sharp termination, with a peak above the cliff, and deep water close up to it.

Ponta de Fayal, the next point, is comparatively low and narrow, and has a perpendicular rocky cliff extending from its outer extreme along its N.W. side. Outside the point, bearing *N.* 40° *E.* one-third of a mile off, is a black

basaltic rock, called the *Ilheo de Fayal*, with a sugar-loaf rock in its centre, 74 ft. high. A quarter of a mile S.E. of the point there is a sharp, bold, rocky spur. The small town of *Fayal* lies up the bay between them. The cliffs from which this spur projects rise to a considerable elevation, and form the sea-face of a singular flat-topped mountain, named *Penha d'Aguia*, or *Eagles' Rock*, whose summit is 1,915 ft. high.

Ponta da Cruz is the outer extreme of a small peninsula, 1 6-10th miles S.E. of Ponta do Fayal. It is surrounded by low rocky cliffs, and in front of it there are four detached rocks, the outer one of which is 500 yards off the point. To the S.E. of the point is a bay, three-quarters of a mile across, called *Porto da Cruz*. It has a shingle beach at its head, and here is also the little town of *Santa Cruz*. The coast beyond consists of bold rocky cliffs, of no great elevation at the sea, but the land rises above them precipitously. The last habitation seen on this part of the island was close to the coast, half a mile beyond Ponta da Cruz.

Ponta de San Antonio is 1 and 9-10th miles to the E.S.E., and is a bold rocky point. Two rocks lie close at the foot of it, and half a mile inland is a mountain, 2,510 ft. high, densely covered with trees. A dreary iron-bound coast, without inhabitants, extends for 5½ miles to *Ponta do Castello*, the cliffs of which are of reddish tufa, 534 ft. high, bold and perpendicular. At the foot of the bluff, 100 yards off, is a breaking rock. The shore throughout is broken into innumerable small coves and bold fantastic points, with a great variety of detached rocks, but in no case beyond 250 yards from the shore. A mile and three-fourths from Ponta de San Antonio, and about six-tenths of a mile inland, is a high green woody peak, named *Castanhas*, 2,058 ft. above the sea. The land East of it has a steep descent to Caniçal. Three miles and a half to the East is *Ponta Bode*, a bluff, with a bay on each side of it. One mile and a half further is Ponta Rosto, with a group of rocks off it. There are other rocks off this point which need not here be particularized.

The bank of soundings extends further off this part of the coast than any other, except Ponta Pargo, and the depths over it are tolerably regular, except in front of Ponta da Cruz. Its breadth hereabout is from 2½ to 3 miles, and the depth from 20 to 80 fathoms, the bottom generally of dark gray sand, and occasionally with coral.

5.—THE CANARIES, OR CANARY ISLANDS.

This group of islands was supposed to be known to the ancients under the name of the *Fortunate Islands*. An expedition to conquer it was undertaken in 1334 by Louis de la Corda, a Castilian prince, but it was repulsed by the bravery of the original inhabitants, the Guanches. It was left until the year 1402, when Jean de Béthencourt, a baron of Normandy, took possession of Fortaventura and Lanzarote, for John, King of Castile, and Alphonso, King of Portugal. Prince Henry of Portugal made several ineffectual

attempts to conquer the archipelago, which finally, after much negotiation, was ceded to Spain in 1479 by treaty. The brave Guanches, in the almost inaccessible rocks of Tenerife (or *Hell* as it was termed) defied the Spaniards, and were not thoroughly subdued until 1496.*

The land of the Canary Islands is generally high, being varied by volcanic mountains, among which that called the Pic (or Peak) of Tenerife, is super-eminent. The inequality of height is, however, so great as to produce differences in the temperature of the different islands. For eight months in the year the summits, excepting those of Lanzarote and Fortaventura, are covered with snow; yet in the valleys, and on the shores, the cold is seldom so great as to render fires necessary. A great proportion of the surface of the islands is covered with lava, calcined stones, and ashes, formerly emitted by volcanoes, the remains of which are still visible in all the islands and some of them, among which is the Peak of Tenerife, are not yet entirely extinguished. The number of inhabitants, according to the census of May, 1857, was 234,046; in 1867, 267,036. The first discoverers found neither corn nor wine, though at present there is both; cochineal, tobacco, barilla, and orchilla, are also largely exported. The canary bird is still found in the country.

"In February, 1867, the navigation and port dues established by Royal Order of December 17, 1851, which had till then not been exacted in the ports of this archipelago, were by order of the government imposed upon Spanish and foreign vessels entering the ports of these islands, in which artificial works have been constructed, namely, Santa Cruz, Tenerife; Las Palmas, Grand Canary; Santa Cruz, de la Palma; and Arrecife, Lanzarote. The artificial works alluded to in the above-mentioned ports, or rather roads, may be said to be only commenced, although they have been in the course of construction for years, and afford at present no protection to vessels at anchor; the petition of the board against these dues might, on this ground, be favourably entertained as regards the anchorage duty."—*Mr. Consul Grattan*, 1868.

Free Ports.—On July 27, 1852, a Royal Order arrived at Santa Cruz, Teneriffe, declaring the following ports of this archipelago free ports, the order to take effect on October 10 of that year:—Santa Cruz and Orotava, in Teneriffe; Las Palmas, in Grand Canary; Arrecife, in Lanzarote; Santa Cruz, in the Island of Palma: Puerto Cabias, in Fuerteventura; and San Sebastian, in Gomera.

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* ALLEGRANZA (the northern isle) is synonymous with *jayous*, a name given by the first conquerors of the islands, Jean de Bethencourt, and Gadife de Salle. This was the first point on which they landed. After remaining several days at Graciosa, they conceived the project of taking possession of the neighbouring isle of Lanzarote, where they were welcomed by *Guardarfia*, sovereign of the Guanches, with the same hospitality that Cortes found in the palace of Montezuma. The shepherd king, who had no other riches than his goats, became the victim of coward treachery, like the sovereign of Mexico!—*Humboldt.*

The history of the Canary Islands is very fully described in a work printed for the the Hakluyt Society, entitled "The Canarian; or Book of the Conquest of the Canaries in 1402:" by Messire Jean de Bethencourt, Kt., composed by Pierre Bontier, monk, and Jean le Verrier, priest. Translated and edited by Richard Henry Major, F.S.A., &c., &c. London, 1872.

Port Dues.—All goods landed from foreign countries in Europe, the coast of Asia, and Africa within the limits of the Mediterranean, and the coast of Morocco in the Atlantic, pay 5 reals vellon per ton of 1,000 kilog., and 3 reals for each passenger that disembarks; from all other ports, 10 reals per ton of goods landed, and 5 reals for each passenger. Vessels engaged in the coasting trade between ports in the Spanish Peninsula and adjacent islands, pay 3 reals per ton on goods landed, and 2 reals on each passenger. Pilotage (not obligatory), 67·50 reals in the day-time, and double at night. Government stamp to clearance, 2 reals. Ballast, $1\frac{1}{3}$ dollar per boat load, said to contain from 2 to $2\frac{1}{2}$ tons. Ballast guard, per day, 15 reals vellon. (1852.)

Vessels may pass between the Canaries, and through their principal channels; as there is no known danger but what may be plainly discerned, excepting a sunken rock, laid down in some charts, in the southern part of the channel between Tenerife and the Grand Canary, about 8 leagues E.S.E. of the South point of Tenerife, and 4 leagues westward of the centre of Canary, but which is not shown in the survey of Admiral Vidal, and another off the East point of Tenerife.

In sailing from Funchal to Tenerife, keep well to the westward, steering S. by W. $\frac{3}{4}$ W. (*nearly South*) in order to avoid the *Salvages*, which are very dangerous in the night.

If prevented from weathering the Salvages or the Piton (described hereafter) by prevalent westerly and S.W. winds, common in the months of January and February, when a heavy swell may set the ship much to leeward, you may safely bear up and run to leeward of the Great Salvage; only observing that if the swell be very heavy you must cautiously avoid three shoal spots, lying to the northward and eastward of that isle. Of these, the northern one is about three-quarters of a mile to the northward (*N.N.W.*) of the isle; the inner one on the N.E., 250 fathoms from it; and the outer, in the same direction, 1 and 1-10th miles. Two others, with 3 and $3\frac{1}{2}$ fathoms, lie at about half a mile from the eastern shore.

The **SALVAGES** consist of an island named *Ilha Grande*, or the *Great Salvage*, a larger islet named *Great Piton*, and a smaller one called the *Little Piton*, together with numerous rocks. The *Great Salvage* lies in lat. 30° 8′, long. 15° 55′. It is of very irregular shape, and has a number of rocks about it within the distance of a mile. It is much intersected, and has several deep inlets, the most accessible of which is on the East side. It is covered with bushes, amongst which the thousands of sea-fowl make their nests. It is surrounded on all sides with dangers, most of which show, but many require all caution in approaching.

The *Great Piton* lies at the distance of $8\frac{1}{4}$ miles W.S.W. $\frac{3}{4}$ W. (*S.W.* by *W.*) from Ilha Grande. This isle is $2\frac{3}{4}$ miles long, N.E. $\frac{3}{4}$ E. and S.W. $\frac{3}{4}$ W. (*N.E. by N. and S.W. by S.*) and has a hill or peak near its centre. The Little Piton lies at a mile from the western side of the former, and is three-quarters of a mile long, nearly in the same direction; both are comparatively narrow. These isles are seated upon, and surrounded by, one dangerous rocky bank, which extends from the western side of the little isle half a league to the westward.

It has been said of the Great Piton, that, in some respects, it resembles the largest Needles Rock at the West end of the Isle of Wight; and, at a great distance, looks like a sail. Its southern part appears green; its northern part barren. It may be seen 5 or 6 leagues off. The Little Piton is very flat, and is connected to the South point of the greater one by a continued ledge of rocks. The whole of the eastern side of the Great Piton is rocky and dangerous.*

LANZAROTE is above 3,000 ft. high, and its mountains may be discerned at a great distance. On approaching it appears black, rocky, and barren, and it has many extinct volcanoes. From its northern extremity, in lat. 29° 14′, a barrier of precipitous cliffs rise to the height of 1,500 feet, extend in a S.W. direction 7 miles, and terminate in a sandy plain, where, in 1825, a volcanic eruption took place, and two considerable hills were thrown up, which were burning in 1835; a stream of lava, from 200 to 300 yards broad, found its way to the sea in the bay. The shore along all the N.W. side to the S.W. extremity of the island is high and precipitous, with the exception of a cove, called *Januvia* or *Janubio*, once a harbour for small vessels, but converted into a salt-water lake by an eruption in the year 1765.

On the eastern side of the island the shore is much lower than the western; near the middle of it is the Port of *Naos*, a small but secure harbour, formed by several rocky islets, and having two entrances, the northern with a depth of 12, and the southern of 17½ ft. at low water, with a tidal rise of 9 ft. During winter, nearly all the vessels of the island resort to this place. Two bomb-proof forts, the one mounting 11, and the other 12, heavy guns, defend the respective entrances. The town of *Arecife* is situate immediately to the southward of the port; many of its houses are large, and the streets are capacious; inhabitants about 2,500. The entire population of the island is estimated at 17,500. During the year 1876, 57 vessels visited Lanzarote.

The greater part of the inhabitants of Arecife are engaged in the fishery on the opposite coast of Africa, which gives employment to between 400 and 500 men from this island alone, about 250 from Fuertaventura, and proportionably from the other islands.

The highest land in Lanzarote is *Montana Blanca*, above 2,000 ft. in height above the sea, situate nearly in the centre of the island, and cultivated to the summit. The wine of this island is very superior to that of the other islands; the grapes are superior in flavour; the soil selected for their cultivation is decomposed scoriæ.† Camels are used in Lanzarote as beasts of burden, on account of the scarcity of water.

Puerta de Naos.—Any vessel not drawing more than 18 ft. may enter this

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* See "Nautical Magazine," October, 1851, pp. 509—517. The occasion and result of a visit by Rear-Admiral Hercules Robinson in 1813 is there amusingly related. In substance it is, that in 1804 the crew of a South American Spanish ship, bound to Cadiz with produce, and about two millions of dollars in chests, rose upon and murdered the captain, off some islands corresponding exactly in description and site with the Salvages. The treasure was carried on shore, and buried in the white sand above high-water mark in a snug little bay on the South side of the island, and over it was buried also the body of the murdered captain. This tale was told to an English sailor by one of the two survivors, whose tale led to the unsuccessful search by the *Prometheus*. Still the tale appears credible.

† The proceeding description of Lanzarote is chiefly that of Lieutenant Arlett, 1835.

port at high water, spring tides, and lie secure from all winds and weather: although, in sailing along the coast, the shipping appears as if at anchor in an open road, the harbour being formed by a ridge of rocks, not perceivable at any distance, as most of them are under water; these break off the swell of the sea, so that the inside is as smooth as a mill-pond. As there is no other convenient place in the Canaries for cleaning or repairing large vessels, it is much frequented for that purpose by the shipping trade to the island.

Lights.—On the point abreast Cruce Island, in Port Naos, are two light-houses 20 ft. high, each exhibiting a *fixed red* light. The lower light is 50 yards from the shore, 35 ft. above the level of the sea, and visible in clear weather 6 miles. The upper light is about 125 yards farther inland, 47 ft. high, and visible 7 miles. The lights in line N.N.W. $\frac{2}{3}$ W. lead through the S.E. entrance to Port Naos, but the channel is narrow, and should not be taken by a stranger without a pilot.

On the West side of Arecife lies another port called *Puerto de Cavallos*. This is also an excellent harbour, formed, like Puerta de Naos, by a ridge of rocks; but its entrance is shallow, there being no more than 12 ft. of water in it, with spring tides. A square castle, built of stone, stands upon a small island between the two harbours, and so defends them both; this island is joined to the land by a bridge, under which boats go from one port to the other, or from Puerto de Cavallos to Puerto de Naos.

At the North end of Lanzarote is a spacious channel, called El Rio, which is the strait dividing this island from the uninhabited one, called *Graciosa*. A ship of any burden may pass through this strait; for, if she keeps in the midway between the two islands, she will have 6 or 7 fathoms of water all along.

The Rio is, in general, more than a mile wide, and forms the only safe harbour in the Canaries for large ships; but the extreme difficulty of communication with Lanzarote presents an insuperable obstacle to its being resorted to as a harbour for trade. Here basaltic cliffs rise almost perpendicularly to the height of 1,500 ft., and can be climbed only by a narrow path which winds along the face of the precipice; halfway up the cliff is the only spring of fresh water in the island, but rendered useless from its situation, except to a few goatherds. From the bottom of the cliff to the shore of Lanzarote is about two musket-shots distance. The ground in the space is low; and here was a salina, or salt work. The fishermen of Lanzarote have constructed a small stone pier, where boats can land under safe shelter; and on the Graciosa side there is a small bay where landing can always be effected. There are no resources here, nor any inhabitants. Some indifferent water may be got by digging in the sand at some distance from the sea. Fish is abundant and good.—*Lieut. du Marais, French Marine*, 1857.

On the N.E. extremity of Lanzarote are two remarkable rocks, composed of black vitrified matter, but in shape resembling the "Needles," at the western extremity of the Isle of Wight.

If a smooth place to lie in, while the trade wind blows, be required, a ship coming into this harbour from the eastward must run a good way in, and double a shallow point, which lies on the starboard hand, taking care to give it a good berth; and this is easily done by approaching no nearer than

in 4 fathoms; when past it, edge toward Graciosa, and anchor in any convenient depth; for it shoalens gradually toward the shore, close to which there are 2 fathoms. This place in the summer season has been used for careening large ships. Off the Isle of Graciosa the water, however, is not so smooth as at Puerto de Naos, especially if the trade wind happens to blow hard from the East, which sends in a swell that makes it troublesome, if not impossible, to careen a ship properly. But the wind here does not often blow from that quarter, those winds which most prevail being from North and N.N.E. In mooring here, great care must be taken to have a good anchor, with a large scope of cable toward Lanzarote; for in East and S.E. winds heavy gusts or squalls come from the high land of that isle. In the winter the wind sometimes shifts to the S.W.; then it is necessary to weigh, and run back to the eastward, round the shallow point before mentioned, until the ship be sheltered from that wind, and there anchor.

On the South side of the island is Pechiguera Point, where a *fixed light* is shown from a white column, at an elevation of 51 ft., visible 12 miles off. This light marks the western entrance of Bocayna Strait, 6 miles wide, which separates Lanzarote from Fuertaventura and Lobos Island.

The Isle of Allegranza, the northernmost of the Canary Islands, is composed of lava and cinders, the remains of an extinct volcano. It rises to the height of 939 ft. above the sea. The edge of the crater is well defined, and two-thirds of a mile across; its bottom is cultivated for barilla. The western cliffs are precipitous, and 700 ft. in height. About 40 persons were resident on the island in 1835, principally employed in collecting orchilla.

The only landing-place is on the South side, where a cavern extends about 500 paces, slanting from the sea, and terminates in a little sandy bay, open above. At the entrance the rocks form a natural jetty. The village is situate immediately above, and abreast is the only anchorage, half a mile from shore.

Light.—On Delgada Point, the easternmost point of Allegranza, is a dark gray lighthouse with a green lantern, from which a *revolving* light every *half minute* is shown, visible 13 miles off, between the bearings of N.N.W. $\frac{1}{2}$ W. round by East to S.W. by W. $\frac{3}{4}$ W.

Graciosa, forming the North side of the Rio of Lanzarote, is about 5 miles in length and 2 in breadth; and, as may be inferred from its appearance, it is destitute of water. Allegranza is 7 miles to the northward of it.

Near *Clara* is a dangerous rock, 3 or 4 fathoms high, and covered with scoriæ, resembling coke. In the old charts it is called the *Infierno* or Hell Rock, and may have been higher. It is now called the *West Rock*, or *Roca de Ouest*.

Eight miles to the eastward of Graciosa stands the *Roca del Este*, or the East Rock, the craggy summit of an extinct volcano. Many ships have been wrecked upon these islets in the night, being misled by errors in their reckoning and by the currents.

FUERTAVENTURA,—This island is divided from Lanzarote by the channel named *Canal de Bocayna*, which is 6 miles in breadth; the island as shown by the chart is singularly formed and variegated; it is less mountainous than the other islands, yet both the northern and southern extremities rise to 2,500 ft. above the sea.

It has two ports of trade; *Cabras* on the East, and *Tarajalejo* on the S.E.; but Cabras contains little more than 1,000 inhabitants. The anchorage at the latter is indifferent, and at the landing-place, a beach of shingles, still worse.

Lieutenant Arlett says that, although the general feature of Fuertaventura is extreme barrenness, still there are many spots of great fertility; the most conspicuous of these is the valley of *Oliva*, toward the North end, where there is a village of the same name, the residence of the Lieutenant-Governor, a descendant of the Baron Bethencourt, who possesses a very considerable portion of the island. The valley of Oliva is about 15 miles long, and generally from 2 to 3 wide. The only two streams of pure water in the island have their rise in the mountain of the Atalaya, or watch-tower; they are husbanded with great care, and irrigate the whole of the valley.

A paved road across the island, from Cabras to Betancuria, is the only one existing; the other ways being mere tracks following the direction of the valley, where the ground is less cumbered with stones, and softer to the camels' feet. The population is from 17,000 to 18,000, scattered in small villages over every part of the island.

The interior formation of Fuertaventura is as follows:—To the North is a group of extinct volcanoes; some of them, as *Monte Mudo*, on the N.E., rise to the height of 2,160 feet, and they branch to the southward of Port Cabras, East and West to the sea, thence following the direction of the coast on each side for about 30 miles; again uniting, they encircle an extensive and arid plain and several detached villages. From the summit of the hills, the course of some brackish streams may be traced by the verdure they impart. There are also date palms, the only trees, excepting the fig, on the island.

From the southern point of junction of the mountains, one of which, *Chilegua*, on the western coast, reaches the height of 2,160 ft., a narrow sandy isthmus, about 5 miles long and 2½ broad, projects, connecting it with the southern extremity of the island, a peninsula, occupied by the *Monte Jandia*, a mountain which presents the most remarkable features; from the N.W., its precipitous face is seen to rise to the height of 2,820 ft.; and spurs, or buttresses, diverge from its centre to the N.E., East and S.E., by which it may be ascended to a frightful ridge on the summit.

Lobos and Light.—On the South side of the eastern entrance of the Bocayna, very near the N.E. shore of Fuertaventura, lies the little island of *Lobos*, or Seal's Isle, which is about 1½ league in circumference, uninhabited, and destitute of water. On the North point of this island is a dark yellow building, with a green lantern, from which a *red light* is shown, and near it is a good road for shipping; the mark for which is, to bring the East point of Lobos to bear nearly N.E. by N., and anchor halfway between it and Fuertaventura, or rather nearest to the latter. Although this road seems to be open and exposed, yet it is very safe with the trade-wind, for the water is smooth, and the ground everywhere clean, being a fine sandy bottom. Directly ashore from the road, on Fuertaventura, is a well of good water, of easy access.

Through the broad channel, *La Bocayna*, ships sail very safely, as it is deep in the middle, and shoalens gradually toward Lanzarote, near to which

are 5 fathoms of water; but very near or close to Lobos, the ground is foul and rocky. In this passage vessels of any burden may find room enough to ply to windward, and there is no necessity of approaching too near to Lobos.

When a vessel comes from the eastward, with the trade-wind, and is passing through the Bocayna to the westward, so soon as she brings a high hill on Lanzarote directly to windward of her, she will be becalmed, and soon have the wind at S.W. Should this happen, make short tacks until you obtain the trade again, or a constant northerly wind, the first puff of which will come from West or W.N.W. So soon as this is perceived, you must not stand to the northward, otherwise you will immediately lose it again, but must steer toward Lobos; for the nearer you approach this isle the more will you have the wind; so that, before you are two-thirds over, you will meet with a steady wind at North or N.N.E.

When there is a great westerly swell hereabout, the sea breaks horribly on the rocks at the N.W. end of Lobos. Captain Glas affirms, that he has seen breakers there nearly 60 ft. high; of which, were one to strike the strongest ship, she would be staved to pieces in a moment. "When I first saw," says Captain Glas, "those mighty breakers, our ship had just passed through the channel, between Fuertaventura and Lobos; we had a fine brisk trade wind at N.N.E., and although there were no less than 10 fathoms of water when we came into the westerly swell, yet we trembled lest the waves should have broken, and thought ourselves happy when we got out of soundings. We heard the noise of these breakers, like distant thunder, after we were past them 6 or 7 leagues."

The Lighthouse on *Jandia Point*, the S.W. point of Fuertaventura, a low rocky point, shows a *revolving* bright light, appearing every *minute*, visible through an arc of 274°, or when bearing from S.S.W. $\frac{3}{4}$ W. round by South, and East to N.W. by W. $\frac{3}{4}$ W. It is 108 ft. high, and is visible 15 miles off. The conical gray tower is 62 ft. high, and stands about 110 yards from the sea at low tide, in lat. 28° 3′ N., long. 14° 31′ 26″ W. The *Griego Bank* extends about S.W. a mile from the lighthouse. The currents in the vicinity form into strong eddies, and a wide berth should be given to the point.

CANARIA, or Grand Canary.—The Isleta, or N.E. point of this island, lies 16 leagues N.W. by W. $\frac{1}{4}$ W. (*W. by N.*) from Point Jandia, the S.W. end of Fuertaventura; and, in clear weather, either of these islands may be seen from the other. The centre of Canaria is exceedingly high, and full of lofty mountains, which tower so far above the clouds as to stop the current of the N.E. wind that generally prevails here; so that when this wind blows hard on the North side of the mountains, it is either quite calm on the other side, or a gentle breeze blows upon it from the S.W. This island is the granary of the Canarian Archipelago, and has, in some districts, two wheat harvests in the year—one in February, the other in June. Cochineal is largely produced, and tobacco grown. During the year 1876, Spanish vessels to the number of 857 visited Las Palmas, and others to the number of 136, including 99 British.

Isleta Point Lighthouse.—On the N.E. end of Canaria is the peninsula called the *Isleta*, 2 or 3 leagues in circumference; the isthmus, by which it is connected with the main island is low and sandy, about 2 miles long, and

a quarter of a mile broad at the narrowest part of it. On the N.E. part of this peninsula stands a conical gray lighthouse, which shows at 817 ft. a fixed light, with *red flashes* every two minutes. Visible 18 miles off.

On each side of this isthmus is a bay, which, being exposed on the N.W. side to the swell of the sea, is therefore an unfit road for shipping; but small barks get in between a ledge of rocks and the shore, and lie there smooth and secure from all winds and weather. Here the natives repair their small vessels.

On the other side of the isthmus is a spacious sandy bay, called by some *Puerta de Luz*, and others *Puerta de las Isletas*, from some steep rocks or islets at the entrance of the bay, toward the N.E. This is a good road for shipping of any burden, with all winds, except from S.E., to which it is exposed; but that wind, which is not common here, seldom blows so hard as to endanger a ship.

Shoal ground, of 6½ fathoms, was found by H.M.S. *Resistance*, one of the ships of the channel squadron in 1875, when proceeding out of the anchorage, then one of 7¼ fathoms, and immediately afterwards the water deepened to 10 and 11 fathoms, the approximate position assigned to the shoal soundings, is, Luz Castle bearing N. ½ W., distant 1 1-10 mile, and Fort S. Catalina N.W. by W., 7 cables.

The landing-place is the very bight or bottom of the bay, where the water is generally so smooth, that a boat may lie broadside to the shore, without danger. Thence, along shore, about a league to the southward, is the city of *Palmas*, the capital of the island, where a light is shown at night on the mole. Shipping, that discharge their cargoes at Palmas, generally anchor, in good weather, within half a mile of the town, for the quicker despatch; but that place is not a good road.

The next port of any consequence in Canaria is *Gando*, situated in the middle of the East side of the island. It is a good place for shipping with all winds, except from the southward; and there good water, with other refreshments may be had.*

Las Palmas is a large handsome town, containing 18,000 inhabitants; it has a cathedral, hospital, and college. It is well supplied with water, having fountains in all the principal streets; and its market, likewise, is well supplied. The city appears to great advantage from the sea, the streets rising regularly above each other, which gives it a very commanding aspect. It extends at least a mile in length. There is another large town, with a lofty church, about 4 or 5 miles to the southward, which stands considerably higher and more inland than Palmas. From the number of houses seen, while sailing along the island, it has the appearance of a considerable population, and of being well cultivated. A *fixed light* is shown from the mole.

Canary affords more anchorages than any of the other islands; the bank almost everywhere extending farther. During summer there is here a con-

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* The pilots of Tenerife assert that a rock, with only 12 ft. of water over it, lies W.N.W. 2½ leagues from Point Aldea, the western point of the Grand Canary, and that the sea breaks on it in rough weather. Its precise situation appears to be unknown.

stant N.E. wind; the land, obstructing its course, causes the calms which prevail off the S.W. shore to the distance of 8 or 9 miles, when the aerial currents again unite. Within this space a westerly current runs close in shore, which is advantageous to the coasters.

El Cumbre, or the summit of the highest peak of Canary, has been stated by Lieut. Arlett to be 6,648 feet above the level of the sea; the mountain *Sancillo*, near the centre of the island, which has a large wooden cross on its summit, 6,070 ft.

TENERIFE or Teneriffe.—Point Naga, the N.E. end of Tenerife, bears N.W. ¾ N. (*N.W. by W.*), 15½ leagues from the N.E. point of Canaria; but, from the western part of Canaria to the nearest part of Tenerife, the distance is 10 leagues. In the centre of the island is the famous peak, called, by the ancient and present inhabitants, the *Peak of Teyde*, 12,176 ft. high.

The bay or roadstead of Santa Cruz, on the N.E. coast, is the most frequented of any of the Canaries. About 150 British vessels and 225 foreign visited the roads during the year 1876.

On coming toward the island in clear weather, the peak may be clearly discerned at a great distance.* It first appears like a thin blue vapour or smoke, very little darker than the sky; at a farther distance the shade disappears, and is not distinguishable from the azure of the firmament. Before you lose sight of this towering mountain, it seems at a considerable height above the horizon, although, by its distance, and the special figure of the earth, all the rest of the island, the upper part of which is exceedingly high, is sunk beneath the horizon. But, in general, in sailing toward Tenerife, when the trade wind blows, the island appears as a haziness of the sky, or as a cloud, till within the distance of 5 or 6 leagues, and then the headlands show like land, and are very conspicuous.

Tenerife presents to the eye the most singular object, perhaps, in the northern hemisphere. The island appears, on sailing along the coast, from

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* They say, in the Canaries, that the peak, in very clear weather, is seen from La Bocayna, or the channel between the Isles of Lanzarote and Fuertaventura, at the distance of about 50 leagues.

"The Peak of Tenerife is probably the most striking monument of nature in the world; for, though the Chimborazo (in South America) soars to the height of 22,000, and the Himalayan Dewalgiri (in Asia) to the astonishing height of 27,000, while Tenerife is but 12,176, yet the latter, by its arising directly from the level of the sea, is seen more conspicuously, and stands at a more magnificent elevation. The view from the summit, which it requires a whole day to ascend, is unspeakably grand. On the top of this vast pyramid of basalt is a crater, 40 yards deep, from which vapour continually ascends, and specimens of finely crystallized sulphur are gathered round its lips. From this summit, when the sky is unobscured, the whole island is seen like a model. Rising around it, at a distance, are seen the Canaries, glittering on the horizon, their peaks and pinnacles coloured by every change of day. At favourable times, Madeira and the African coast are visible."—*Captain Alexander*, 1837.

Baron Humboldt says:—"It may be admitted in general that the Peak of Tenerife is seldom seen at a great distance in the warm and dry months of July and August; and that, on the contrary, it is seen at very extraordinary distances in the months of January and February, when the sky is slightly covered, and immediately after a heavy rain, or a few hours before it falls."

North to South, to have once been a complete cinder; and presents to view a great deal of the brokenness and irregularity of half-consumed coke. The resemblance, however, contrary to expectation, becomes less perfect as we approach the peak, the great chimney of the fiery caldrons boiling beneath. The island is of a triangular form, its North and South sides being about 45 miles long, and its West end about 24 miles. Some very interesting particulars of it, with photographic views, are given by Professor C. Piazzi Smyth's account of his astronomical visit in 1856.*

In Baron Humboldt's ascent of the peak, it is stated, that the volcano has not been active at the summit for thousands of years, its eruptions having been from the sides; the depth of the crater being only about 120 ft. The peak forms a pyramidal mass, having a circumference at the base of more than 57,107 fathoms, and a height of 12,176 ft., or rather more than 2 geographic miles. Two-thirds of the mass are covered with vegetation, the remaining part being sterile, and occupying about 10 square leagues of surface. The cone is very small in proportion to the size of the mountain, it having a height of only 537 ft. The lower part of the island is composed of basalt and other igneous rocks of ancient formation, and is separated from the more recent lavas and the products of the present volcano by strata of tufa, puzzalana, and clay.

Capt. Beechey, in his narrative of the voyage of the *Blossom*, observes:— "As I purposed touching at Santa Cruz we immediately hauled up for the land, and it was a fortunate circumstance that we did so; for so strong a current set to the southward during the night, that, had we trusted to our reckoning, the port would have been passed, and there would have been much difficulty in regaining it. I mention the circumstance with a view of bringing into notice the great southerly set that usually attends the passage of ships from Cape Finisterre southward. From this cape to Point Naga, our error in that direction, or more correctly *S.* 33° *W.* (*true*), was not less than 90 miles."

Punta de Anaga, the eastern point of Tenerife, is in lat. 28° 28′ 33″ N., and long. 16° 6′ W. To the northward of the N.E. point of Tenerife is a chain of black rocks called the *Anagas*, which are steep-to, but dangerous. To the South of the N.E. point is a high conical rock close to the shore, called the *Mancha Blancha*, though it is usually of a dark colour.

A *dangerous sunken rock* lies off the East point, which is omitted in the last survey, though it appears in the older charts. It was seen by the mail steamer *Cleopatra* in December, 1859. It is known to the pilots as the *Bajo de la Mancha*, and bears 1½ miles, *East, true*, from Anaga Point, and *E.* by *S.* from the rock described above, as La Mancha Blancha. It has 18 ft. at low water, and 21 ft. at high water. It only breaks occasionally.

* "Tenerife, an astronomer's experiment, or specialties of a residence above the clouds, by C. Piazzi Smyth, F.R.S., 1858." Professor Smyth and a party of scientific men went in Robert Stephenson's yacht, *Titania*, to Tenerife, in June and July, 1856, and carried the instruments up to the flanks of the peak to Guajara, 8,903 ft. above the sea. The results of these observations were very remarkable, and the expectation was fulfilled that the astronomical objects would be seen with much greater clearness and brilliancy when the lower strata of cloud and vapour was passed.

Roque Bermejo Point and Lighthouse stands near the N.E. extreme of Tenerife. The light is a *fixed* white light, varied by a *flash* every *three minutes*, at an elevation of 810 ft. above the sea, illumines the arc of the eastern horizon between *Drago Point* to the South, and the *Anaga Rocks* to the North, and is visible in clear weather from a distance of 35 miles.

The tower is 39 ft. high. It stands at $1\frac{3}{4}$ miles N. $\frac{3}{4}$ W. from Anaga Point, and $3\frac{3}{4}$ cables N.W. $\frac{1}{4}$ W. from Roque Bermejo Islet, which is connected to Roque Bermejo Point by a short reef covered at high water. Drago Point is between Anaga Point and Roque Bermejo Point. The position of the lighthouse is lat. 28° 35′ 25″ N., long. 16° 8′ 6″ West.

Santa Cruz.—At a short distance from Point Anaga, the East point of Tenerife, are the high perpendicular rocks above described; and 4 or 5 leagues thence, on the S.E. side of the island, is the bay or roadstead of Santa Cruz. The best road for shipping here is between the middle of the town and a fort or castle, about half a mile to the northward of it. In all that space ships anchor, from a cable's length distance from the shore, in 6, 7, and 8 fathoms of water, to half a mile in 25 or 30 fathoms. Particular care must be taken, in going in, not to bring any part of the town to the northward of West, lest calms should be occasioned by the high land under the peak; otherwise you will be in danger of driving upon the shore; and, when ashore, will have no ground on the opposite side of the ship, with 200 fathoms of line, so that anchors and cables are of no use.

Here vessels, if moored with good cables and anchors, may lie securely in all winds, although the bay is exposed and open to those which blow to the N.E., East, and S.E.; however, it is not above once in the space of four or five years that they blow so hard as to cause any considerable damage. The surf frequently beats on shore, with great violence, for several days together; and the pier is ill-contrived for shelter.*

Mooring buoys four in number were placed in the roads about 3 cables apart during the years 1873-4. In March, 1875, there were but two of these buoys, one for large vessels moored in 24 fathoms at 350 yards eastward of the mole, the other in the South part of the roadstead in $31\frac{1}{2}$ fathoms with the Torre de la Conception, bearing W.N.W., and at 260 yards from the mole head. The latter buoy was for vessels undergoing quarantine, or requiring provisions or coal.

A *red light*, elevated 26 feet above the sea, is shown from a moveable platform on the extreme end of the mole. It replaces a lighthouse destroyed

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* "The Bay of Santa Cruz is much exposed to all winds between E.NE. and S.W. by W.; and, as the easterly winds are very prevalent, there is generally a great swell setting in, although it seldom blows hard from that quarter of the compass.

"In $17\frac{1}{2}$ fathoms, fine sand and blue clay, directly off the jetty, with the end thereof on with the gateway leading into the town, bearing about N.W., is a convenient berth for watering, and good ground.

"The jetty is built on a curve, to break off the swell, for the convenience of boats, being the only landing-place, where all goods are landed and shipped. Ships generally lie off the jetty, in from 17 to 35 fathoms, good holding ground. The best mark is the high square building, like a lighthouse, just over, and in one with, the mole or jetty head.

"Tide rises about 4 ft., sets round the bay. High water, $4^h\ 30^m$ (?)."—*Mr. William Wood, H.M.S. Tartar*, 1823.

by a storm in 1873. In steering from the South, the light ought to be kept in sight, the coast out of the range of the light being dangerous. At 56 yards from the extremity of the mole another *fixed light* is shown, visible 9 miles off.

The following directions for the anchorage of Santa Cruz were issued in August, 1845, by Mr. Richard Bartlett, the British consul at that place.

While running for the anchorage keep both leads going, and bring up to the northward of the Mole Head; or, bring the clock front of the square church with cupola to bear W.N.W., and anchor with this mark on, or to the northward of it.

"Ships may anchor when in less than 30 fathoms. Give a large scope of chain cable. When the northernmost fort (Fort Paso Alto) bears N.N.E., the depth of water will be about 25 fathoms on the lines pointed out. The shore may be neared without risk, the water being deep, and no dangers that are not apparent. The anchorage to the South of the lines indicated is reserved for vessels in quarantine." The foregoing will be sufficient; but another good anchoring mark is, *not to bring the Mole Head anything North of W.N.W.*

Lieut. Church, of H.M.S. *Ætna*, makes the following observations on the anchorage of Santa Cruz:—"Whilst surveying the Canary Islands in the *Ætna*, we had, of course, considerable experience of Santa Cruz, and had no reason to consider it an unsafe anchorage. During the very many times that the *Ætna* was there, in only one instance did we experience a gale from the south-eastward. Most of the shipping slipped at the commencement, and got into the offing; but we remained at our anchors, and rode it out well. Although a heavy sea tumbled in, there was much less strain on the cables than might have been expected, arising, as it appeared to us, from an offset, which, together with there being a great uphill drag for the anchor, diminishes the chance of driving.

"The church tower with the cupola (San Francisco) open a little to the right of the Mole Head, is considered the usual anchorage, the vessels congregate here to be near the landing-place. But, in a man-of-war, I would (especially if there are many vessels here) anchor considerably to the north-eastward, or windward of this resort, the bank of soundings being wider, and so avoid having merchant ships in the hawser; indeed, I see no reason why ships should not anchor nearly as far North as the Paso Alto Battery, the most northern battery, in case the roads are crowded with shipping.

"I have noticed that ships, coming from the north-eastward to Santa Cruz, run down at too great a distance from the land, and do not haul in till they get nearly abreast of the town. They get a cast or two of the lead with no bottom, and immediately they get into soundings, the anchor is let go in a hurry, the bank being narrow, and the ship's head in-shore, there being little time for consideration.

"Instead of this method of proceeding, I think it would be advisable, on making the N.E. end of Tenerife, Punta de Anaga, to haul in upon the bank of soundings immediately on passing Punta de Antiquerra, as from this point to Santa Cruz the bank extends as far out from the land as at the town, and the anchorage is just as good and as safe anywhere when abreast of the Barrancos. I would get into the depth nearly that I wished to an-

chor in, and then run down with the light wind parallel to the shore. Besides having time to anchor leisurely, there is the advantage of being enabled to let go the anchor under foot, wherever you may be.

"Should it fall calm while the ship is outside soundings, she may be taken away to leeward by the southerly set, which once caused us twenty-four hours' trouble to get back again. From experience, we latterly adopted the system I have mentioned."

Commander T. L. Barnard, in H.M.S. *Vixen*, says:—"With the wind on shore, I should recommend a steamer to steer boldly under the sterns of the vessels at anchor off the Mole Head, and bring the head to wind with the Mole Head on with the church tower, in from 25 to 30 fathoms."

The aspect of Santa Cruz is gloomy, and the heat is uncommonly excessive. On a narrow and sandy beach, houses of dazzling whiteness, with flat roofs, are stuck against a wall of black perpendicular rocks, stripped of vegetation. A fine mole, built of freestone, and the public walk, planted with poplars, are the only objects which break the sameness of the landscape.

Orotava.—The next best port to that of Santa Cruz is the port of *Orotava*, on the northern side of the island, and which lies about 8½ leagues to the westward of Point Anaga. Here the riches and fertility of the island are chiefly to be found, for here the wine is mostly made, and shipped when the weather allows. It is a good harbour in the summer season, or from the beginning of May to the end of October; but in winter ships are often obliged to slip their cables and put to sea, lest they should be surprised by a N.W. wind, which throws in a heavy sea; luckily these winds rarely happen, and in general give warning, so that a vessel has time to get away. Straggling rocks project about two ships' lengths from shore, on which the sea breaks furiously. It is commonly calm in the road, but there is almost always a long northerly swell, that causes ships to roll very much.

The anchorage is in 50 fathoms, about 1½ mile from shore, with the peak bearing S.W.; and it is proper to continue a pilot on board whilst lying here.

Orotava stands upon a gentle slope at the foot of the mountain, and is surrounded by fields of corn, gardens and vineyards. The culture of the soil is here promoted to a very great degree, particularly in some patches so elevated and so secluded as to appear inaccessible to the husbandman. But the plain is very forbidding; and the beach is composed of naked, pointed, and cinereous, or scorched rocks.

PALMA.—From Point Teño, the western end of Tenerife, to the nearest part of the Island of Palma, the distance is about 15 leagues. The summit of this island is higher than the general level of Tenerife, its peak excepted; hence some navigators run toward it with great confidence in the night.

The chief port is that of Santa Cruz, on the East side of the island. The mark by which a stranger may find it is the following:—When he approaches the East side of the island, Palma will appear shaped exactly like a saddle. Let him steer so as to fall in a little to windward of the lowest place, or middle of the saddle, till he comes within a mile of the land; then,

running along shore to the southward, he will perceive the town close by the sea shore, and the shipping lying in the road; but, as the land behind the town is high and steep, one cannot discern the shipping till within a mile of them. The road is within a musket-shot of the shore, where vessels commonly ride in 15 or 20 fathoms of water, and are exposed to easterly winds; yet, with good anchors and cables, they may remain with great safety in all winds; for the ground is clean and good, and the great elevation of the island, with the perpendicular height of the land facing the road, repels the wind that blows upon it, though ever so strong.

When there is a great N.E. wind at sea, it comes rolling into the bay, but the want of wind and the deepness of the water deprive it of strength and power; so that ships, in such a case, ride here with a slack cable. These circumstances render the road of Santa Cruz, in Palma, more secure than any of those of Canaria or Tenerife; but in the winter the rolling swell which comes into the bay, breaks high upon the beach, and prevents boats from going off, or landing, for the space of three or four days together.

Santa Cruz de la Palma is a large town, but not so good as that of Palmas, in Canary, or the towns of Tenerife. In coming to it from the offing, a church on one of the heights and some windmills are the first objects seen. It has several forts, and near the mole is a castle, or battery, mounted with a few cannon. In the middle of the town, near the great church, is a fountain, filled by a rivulet, which plentifully supplies the inhabitants with good water.* A mole was completed in 1875.

Taxacorta or *Tassacorta*, the port next in consideration to that of Santa Cruz, is on the S.W. part of the island; it is exposed to westerly winds, and little frequented by any vessels, excepting boats.

In all the island there is no town of any note, excepting Santa Cruz, but many villages, the chief of which are St. Andres and Tassacorta. In the north-eastern part, inland, is a remarkable high mountain, called La Caldera, or the Caldron, being hollow, like the Peak of Tenerife.

Light.—On Cumplida Point on the N.E. side of Palma, a *revolving light* is shown, and eclipsed every minute, illuminating an arc of 239° between Caviota and Barlovento Points. Elevated 207 ft., and visible 20 miles off.

GOMERA is divided from Tenerife by a perfectly safe channel 15 miles wide. The island is very rugged and uneven, the middle being a plateau, above which the mountain Alta Garaone rises to 4,440 ft. The shores are everywhere rugged, and nearly perpendicular to the sea. A few rocks lie off it, and there are some small sandy beaches, at one of which, on the East side, is the principal town.

The Port of Gomera lies S.W., about 17 miles from Point Teño, of Tenerife. *St. Sebastian*, the principal town, is situated close by the shore, in the bottom of a bay, on the eastern side, where shipping lie land-locked from all

* The following notice, which appeared in the *Shipping Gazette*, in March, 1840, will be useful to vessels touching at Palma:—"Several English vessels having lately sent ashore their boats at Tassacorta, without receiving the succour they required, I beg, through you, to inform the shipping interest in general, that the orders from the Spanish Government are, that no communication be held, or refreshments given, at any other place, except this and the town of Santa Cruz, on the N.E. side of Palma."—*Canaries*, January 10th 1840.

winds, except the S.E. Here you may anchor at a convenient distance from the shore, in from 15 to 7 fathoms; but as the land-wind frequently blows hard, it is necessary for a ship to moor with a large scope of cable, otherwise she will be in danger of being blown out of the bay. The sea here is generally so smooth that boats may land on the beach without danger. On the North side of the bay is a cove, where ships of any burthen may haul close to the shore, which is a high perpendicular cliff, and there heave down, clean, or repair. When boats cannot land on the beach, on account of the surf, they put ashore on this cove, from whence there is a pathway along the cliff to the town.

The town has plenty of good water, which is drawn from wells in every part of it; and in the winter, a large rivulet from the mountains empties itself into the port. On the South side of the mouth of this rivulet stands an old round tower; and on the top of its perpendicular cliff, on the North side of the cove, is a chapel and a battery, with a few pieces of cannon.

Care must be taken in passing round the East end of Gomera, as a *sunken rock*, the *Bermeja Shoal*, lies 100 yards off shore, at a mile northward of the North point of the bay.

To the best of my remembrance, says Capt. Glas, the land that forms the North point of the bay is the most southerly point of land, on the East side of Gomera, that can be seen from Point Teño, on Tenerife. That land, when one is to the northward of it, at about a league distant, bears a great resemblance to Rame Head, near Plymouth Sound. In going into the bay, it is necessary to stand close in with this point, for the land wind is commonly too scanty for a ship to fetch the proper anchoring place; from that reason it is better to come in with the sea breeze, which generally begins to blow here about noon.

The best place for a ship to lie in here is where a full view may be had along through the main street of the town, and at about the distance of a cable's length from the beach. It is necessary to moor as soon as possible, because of eddy winds that sometimes blow in the bay.

FERRO, or HIERRO.—This island, the westernmost of the Canaries, has neither road nor harbour worthy of particular description. The land rises steeply from the sea, and is craggy on all sides for about a league, so as to render the ascent very difficult. Its summit is an uneven plateau, the highest points of which are 4,580 and 4,990 feet above the sea. At the northern part of the island the sides of these mountains are nearly perpendicular cliffs, commencing at *Point Salmone*, and extending round to the N.W. point, *Pta. de la Dehesa*, and are called *Risco de Taretai*. The only roadsteads are at *Naos*, at the South end, where there are no inhabitants nor shelter; and at *Puerto del Hierro*, on the East side. The latter is only a slight inlet, with a sandy beach between two rocky points, off the northernmost of which is a detached islet, which has a shoal running off for one-third of a mile. In the interior of the island, at the North end, is *Valverde*, the chief town, surrounded by high peaks. It produces, however, many trees and shrubs, with better grass, herbage, and flowers, than any of the other islands, so that bees and honey abound. The wine is poor, and there are only three fountains or springs of water on the island.

DIRECTIONS FOR SAILING AMONG THE CANARY ISLANDS, BY CAPTAIN GLAS.

If a ship, lying at Palma, wants to go to Lanzarote, and will not wait for a fair wind, (which, indeed, seldom blows there, especially in the summer season), let her stand over to the N.W. side of Tenerife, and beat up along shore until she weathers Point Naga; thence with the wind that generally prevails in these parts, she will be able to weather Canaria, and fetch the Point of Jandia, of Fuertaventura, or perhaps Morro Jable, the southern point, whence it is easy to beat up to Pozonegro, along the East side of the island, because there the sea is always smooth. It is not quite so easy to beat up from Pozonegro to the Isle of Lobos; yet it may be done without difficulty when the weather is moderate. If the wind should happen to blow hard, she may stop in the Bay of Las Playas, until it proves more favourable.

From the Isle of Lobos, she will find no difficulty in beating up to Porto de Naos, in Lanzarote. It is not advisable, for those who are not perfectly well acquainted with that harbour, to attempt to conduct a ship in, because the entrances are very narrow.

It is common for ships that come loaded from Europe to Santa Cruz, Tenerife, &c., to have part of their cargoes to unload at Port Orotava; these ships, when the trade wind blows hard, will sometimes find it impracticable to weather Point Naga. When this is the case, bear away to the leeward point of the island, and keep near the shore, where, if you do not meet with a southerly wind, you will be carried by the current, in the space of twenty-four hours, from the S.W. point of the island to Point Teño, whence you may easily beat up to Porto Orotava; for when the wind blows excessively strong at Point Naga, it is moderate weather all the way from Point Teño until within 2 or 3 leagues of Point Naga. But I would not advise a ship to bear away as above directed, unless when the trade wind blows so fresh that she cannot weather Point Naga; because in moderate weather there is little or no wind stirring on the coast between Teño and Port Orotava.

In rounding Point Naga, or Anaga, the *sunken rock* alluded to should be guarded against.

The *Coast of Africa*, East of the Canaries, is level, and is rendered inaccessible by a heavy surf, which breaks on it continually. The Canarians, in the sea between this coast and the islands, employ a number of vessels to fish for bream and cod.

OF THE CALMS OF THE CANARY ISLANDS.

It has been already noticed, in the description of the Island Canaria, that its mountains tower so far above the clouds, as to stop the current of the N.E. wind that generally blows here; so that when the wind blows hard on the North side of the mountains, it is either quite calm on the other side, or

a gentle breeze blows upon it from the S.W. These calms and eddy-winds, occasioned by the height of the mountains above the atmosphere, extend 20 or 25 leagues beyond them to the S.W. There are calms beyond, or to leeward of, some of the rest of the islands, as well as Canaria; for those of Tenerife extend 15 leagues over the ocean, the calms of Gomera 10, and those of Palma 30. "I have," says Captain Glas, "been frequently in all the calms of the islands, excepting those of Palma; and, from my experience of them, I may venture to say, that it is extremely dangerous for small vessels, or open boats, to venture within them when the wind blows hard without. It is true, indeed, the wind raises the waves of the sea to a mountainous height; yet those waves follow each other in regular succession; for, were they to fall confusedly one against another, no ship would be able to sail on the ocean. But in a storm, the wind driving the sea before it each wave gives place to the one which follows; whereas, in the calms in the Canary Islands, the sea, not moving forward in the same direction with the sea without, but being, as it were, stagnant, or at rest, resists the waves that fall in upon it from without; and this resistance causes them to break just in the same manner as the billows break upon the sea shore, but with less violence, on account of the different nature of the resistance. This breaking of the waves is only on the very verge of, or just entering into the calms; for within them the water is smooth and pleasant.

"Upon first coming into the calms, the waves may be seen foaming and boiling like a pot, and breaking in all directions. When a vessel comes amongst them, she is shaken and beaten by the waves, on all sides, in such a manner, that one would imagine that she could not withstand their force; however, this confusion does not last long. The best way to manage a ship entering the calms is immediately to haul up the courses, and diligently attend the braces, to catch every puff of wind that offers, in order to impel the ship into them as soon as possible. The crew must not think it strange to be obliged to brace about the yards every two or three minutes, according as the wind veers and hauls; but after a ship is once fairly into the calms, she will either find a dead calm and smooth water, or a pleasant and constant breeze at South or S.W., according as the wind blows without, to which this eddy-wind, as it may be called, always blows in an opposite direction."

7.—THE CAPE VERDE ISLANDS.

The **CAPE VERDE ISLANDS**, a colony belonging to Portugal, derive their name from the nearest point of the coast of Africa, and were discovered, it is said, in 1450, by Antonio Noli, a Genoese, in the service of Portugal. They consist of the Ilha de Sal or Salt Island, Boavista, Maio or the Isle of May, St. Iago, Fuego, or Fogo, Brava, San Nicolao, Sta. Lucia, St. Vicente, and San Antonio, besides several small islets. Of these isles, the most considerable is St. Iago, the chief town of which is the seat of government. The population is estimated at 85,393 persons. Salt is the principal article

of commerce. The first port in the archipelago is Porto Grande on the North side of San Vicente.

We have already shown (pp. 460—465) the usual courses and allowances to be made in sailing to these islands; and have there noticed the fogs by which they are frequently surrounded. The estimated limits of the N.E. trade-winds in the vicinity may be seen in pp. 199 and 200. Thus much premised, we immediately proceed to the description of the isles.*

ILHA de SAL.—The Isle of Sal lies between lat. 16° 34′ and 16° 51′, and on the meridian of 23° W. The northern part of the isle is mountainous; the southern very low and sandy. Both the eastern and western sides are irregular; and the former has almost continued reef, along shore, from North to South.

Sal derives its name from the salt ponds upon it, wherein the water crystallizes into a beautiful salt, the chief production of the isle, as the land is so barren as to bear no trees nor verdure, excepting a few inconsiderable shrubs.

On approaching the island from the North, it will be found in general that the currents are very irregular. You may, on approaching, see the high land at 14 leagues off; sometimes at a greater distance. The land makes in three hillocks, of which the northernmost is the highest. This is the *Peak of Martinez*, in the N.E., the summit of which is 1,340 ft. above the level of the sea.

The best roadsteads of Sal are on the western side of the island; but there are three small bays on the eastern side, and one on the South. The middle bay on the eastern side, where a ship may lie, is apparently sheltered from the N.E. by a sandy reef stretching out to the eastward, and here salt may be obtained.† The other bays on this side are open to the N.E. trade-wind, which makes a very heavy sea on the beach.

Great caution is required on approaching the South end of the island in the night, it being so low as hardly to be seen 10 miles off in the day. Keep your lead going, and approach no nearer than in 30 fathoms, unless bound into the *South Bay*, which lies between the S.E. and South points of the island.‡

The S.E. point of Sal is called *Wreck Point*, H.M. sloop *Erne* having been wrecked near it in 1819; this is surrounded by a reef. From *South Point*, forming the West side of the bay, a dangerous sandy spit extends about 1

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* Mr. Finlaison has said that, "In leaving Tenerife for the Cape Verde Islands, you will certainly have the wind from E. by S. to N.E. as you approach the islands." He also adds, that in the passage a current was generally found setting *from S.S.W.* at the rate of half a mile an hour, which is contrary to the current on the African coast. (See pp. 337-8.)

† *Firestone Hill.*—A promontory on the eastern coast stands at 2 leagues from the North Point. At the back of this is the Salt-pond Hill, a natural curiosity, as upon this is the salt-pond, 150 feet above the level of the sea. The surface of the pond, in a circular form, is 45 feet below the top of the hill.

‡ Hearkening for the noise of the surf will often give ample warning in approaching land, either during a fog or by night, and ought to be attended to, if heard; but no one ought to run rashly, making certain of hearing it.—*A. L.*

mile into the sea. If coming into the bay between these points, after rounding Wreck Point in 8 or 9 fathoms, bringing that point to bear E. by S. and the opposite point W. ½ N., anchor in 9 fathoms, sandy bottom. Here you will be sheltered from the N.E trade, and lie in perfect safety.

At 5 miles to the West, from the *North Point* of Sal, is *Manuel* or the *N. W. Point.* Nearly true South, 8½ miles from the latter, is a little islet, called *Bird Isle,* near a promontory, *Lion's Head,* which is 620 ft. high. At a league to the northward of Bird Isle is a small bay, called *Palmyra Bay,* and immediately to the south-eastward of the Lion's Head is *Mordeira Bay,* which is one of the best in the Cape Verde Islands.

Mordeira Bay is in a semi-circular shape, 1 league in extent between its outer points, *Lion's Head* and *Turtle Point.* It is a safe anchorage during the N.E. breezes. Captain Bartholomew says that it has plenty of fish and turtle, but has no watering-place ; nor could water be procured by sinking casks in the sand.

H.M. ships *Leven* and *Barracouta* anchored in this bay in 1822, and caught a great many most delicious fish ; yet the place produces little else but salt and orchilla ; a few goats contrive to pick up a scanty subsistence, but eagles abound.

The principal mark for anchoring in Mordeira Bay is Bird Island just shut in with the foot of Lion's Head, at 1¼ mile from the bluff land ; there are several foul spots ; therefore the ground should be examined before the anchor be dropped.

From Turtle Point, the South point of Mordeira Bay, to the South point of Sal, the distance is 1½ league. The ground between is smooth, and has 7 fathoms over it, at half a mile from shore, which is sandy ; but be careful if you anchor, that the ground is clear. In rounding the South point, with the spit extending from it, approach no nearer than in 10 or 8 fathoms, as the latter is steep.

The latitude of the Lion's Head, according to the Admiralty Survey, is 16° 41′ ; long. 23° 0′ 15″. High water, 7ʰ 15ᵐ ; rise, 5 feet.

Between Sal and Bonavista there is generally a strong current.

BONAVISTA.—The Island of Bonavista, properly *Boavista,* has been so called from the beautiful appearance it made to the first discoverers in the year 1450. The face of it is variegated ; partly low, partly rocky and mountainous ; formerly fertile, now more barren. Salt is the principal article of trade, which the inhabitants readily exchange for old clothes, biscuits, meal, and raw silk. The principal place is *English Road,* on the N.W.

The eastern side of Bonavista is partly environed by a reef ; and on the N.E. are the reefs on which the *Hartwell,* East Indiaman, was lost in 1787 ; and on which the *Resolution,* Capt. Cook, was nearly driven by a southerly current. Half a league nearly from the West end is a coral reef, on which the sea breaks ; and at times the current sets on it very rapidly.

From the South end of Sal, the N.W. point of Bonavista lies *true* South, or S. by W. ¼ W. by compass, distant 7 leagues ; and from the same end of Sal, to clear the N.E. reefs, the course by compass is S.E. by S. 11 leagues, in order to allow for the current that sets to the S.W. on Bonavista ; be sure to make this course, and it will bring you to the eastward of these reefs, the easternmost part of which lies in lat. 16° 10′.

Bonavista is of an irregular shape, but nearly octagonal, and each way 3 leagues in extent. Its eastern side is low, but the interior is mountainous, and a ridge of high land from N.W. to S.E. divides the island into two unequal parts. Of this island chain, *Mount Juan Fernandez* is the northern part, and the southern is called the *South Mountain*. Two miles from the N.E. end are two conical hills, *Mounts Ochel* or *Ochello*, and *Broyal;* at the N.W. end is the *Peak Reshee*, and in the S.W. is the *Platform Hill*, with an elevation within it called the *Man Mountain*. *English Road*, on which the town is situate, forms a bay of 5 miles in extent from N.E. to S.W., and its northern part is protected by an islet, called by the English *Small Island*. The South point of this bay is *Coral Point*; and off this point, which is foul, at the distance of half a league, is a coral reef.

Off the N.E. coast, as already shown, are the Hartwell Reefs, and three kays, called *Dutch*, *Braithwaite*, and *North Kays*. Between these is sufficient depth of water for ships, in case of necessity, and proper depths for anchorage, under the lee of the reefs; but many rocks are here scattered, with only 12 or 13 ft. over them, and 4 fathoms close along them, on which, with a wind, the sea breaks very high. Of the channels between these reefs, the best lies between a ledge to the E.S.E. of Braithwaite or the Middle Kay, which is always visible, and Dutch or the South Kay. This channel is three-quarters of a mile broad, and has regular soundings, from 15 to 5 fathoms; having been tried by H.M. sloop *Bulldog*, which often sailed in and out of it, and several times anchored under Braithwaite Kay, with that kay N.E. by E., Dutch Kay, S. ½ W.

Braithwaite Kay is about 2 miles from the shore. The passage to the north-westward, between this and North Kay, is half a mile broad, and its least water is 7 and 8 fathoms. The passage between Dutch Kay and Bonavista is narrow, but in the best water are 7 fathoms. Dutch Kay bears from Braithwaite Kay S. ½ W. (*S. by E.*) 2¼ miles.

The *North Kay* is connected to the shore by a reef, having over it only 5 ft. of water. When this kay is in line with the summit of Mount Ochel, or the N.E. high mountain in Bonavista, it bears about W.S.W. ½ W.

In sailing out to the south-westward, with the wind easterly, stand well to the southward, taking advantage of the current here setting easterly, and take care not to borrow too near the back of the reefs.

Bonetta Rock (?)—A ship, the *Madeline*, bound to New South Wales, was reported to have struck and been wrecked on a reef, at about 8 leagues E.N.E. from Bonavista, in April, 1835. Some smart but justifiable remarks upon this report were afterwards given in the "Nautical" (December, 1839), the writer of which represents the case as a matter "very nicely cooked up for the edification of seamen," and the benefit of a certain "market." He adds that Captain Vidal has, by his researches in the *Ætna*, satisfactorily proved that no such danger as the Madeline or Bonetta Reefs have any existence.

These imaginary dangers were also sought for by the American exploring squadron, as shown hereafter, and the result seems to be, that the *Madeline* was impelled to the S.W. by the current, and wrecked on the *Hartwell Reef* of Bonavista. The question of the existence of this danger has been definitely settled by Lieutenant Lee, U.S.N., on the cruise of the *Dolphin*, as he

found a depth of 1,580 fathoms on the spot, and great depths close up to the islands, as shown hereafter.

The long list of wrecks on the Hartwell Reef, and the fact of so many vessels being to the *westward* of their reckonings, and that in the short run from Madeira or the Canaries, will give great weight to the fact of the westward tendency of the currents, which, as has been stated before, tend directly towards this formidable danger, and therefore will call for all the vigilance and care so imperatively necessary for the safety of ships passing this place.

The *Brazen Hill and Point* (otherwise *Brazen Head*), in lat. 16° 2′, on the S.E. coast, is the first high land to the southward of *East Sand Head*, which is the easternmost point of Bonavista. The Head is remarkable, being very bluff and perpendicular on each side. The beach is sandy. *Point Urrateo*, or the *South Point*, which is nearly 3 leagues more to the south-westward, is low and foul, and an islet of the same description lies at three-quarters of a mile to the eastward. To the westward of the point is anchorage in what is called *Portuguese Road*, with Platform Hill bearing about N.N.W. and nearer in-shore, in from 13 and 14 to 8 and 6 fathoms. In the latter depths the landing-place will bear N.E. by N. more than a mile distant.*

North and West Coasts.—From the *North Kay*, off Mount Ochel, already described, the coast is foul to *Broyal Point* on the North coast; and there are several reefs between the latter and the N.W. end of the island, which is called the *North Point and Reef;* Small Island, which forms the N.W. side of English Road, is 4 miles hence to the S.S.W. (*S. by W. ¼ W.*)

English Road, on the West coast, is a safe anchorage during the summer months, while you have the N.E. breezes, but there are three reefs in it, as shown on the chart. Vessels generally haul close round Small Island in 6 and 7 fathoms, and pass within the first reef (of 10 ft.) in order to avoid the necessity of making a tack to get to the anchorage. The best mark for the latter is the town open with the N.E. end of Small Island, and the highest part of that isle about N.E. by E. The Ten-feet Reef generally shows itself; but when this is not the case, a stranger will do well to stand outside rounding it at about 1½ or 2 miles from Small Island, approaching it no nearer than in 6 fathoms, and, after once opening the town, taking care not to shut it again.

The new town is on the middle of the bay, and the second reef (*New Town Reef*) lies to the westward of it, at a short distance from the beach. The *Inner Reef* lies, in like manner, half a league more to the northward. The Ten-feet Reef is about 100 fathoms in length, and extends nearly East and West, at rather more than a quarter of a mile from Small Island.

Mr. Keilor has said:—"We experienced in a calm a very large sea, breaking in every part of the bay, and were at the same time riding with a very short scope of cable, by reason of a strong current setting out of the

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* Mr. Finlaison says, that it is requisite to give the point under Platform Hill a good berth, as there is a reef extending from it. In the day you may see the sea breaking on it The mountain E.N.E. clears the danger.

bay, against the sea: this current runs so high as to frequently break on the deck."

In the rainy season, which is during the months of July, August, and September, the Island of Bonavista is subject to light airs and changeable winds, with heavy swells in the bay and roadsteads.

The tide flows in English Road at 7 o'clock, on full and change days, and the sea rises 5 ft. Observe that there is no fresh water for shipping at Bonavista. There is water, but not plenty of it, near the Portuguese Road.

Leton Rock, or *John Leton's Rock*, a dangerous reef, lies to the S.W. of Bonavista. This shoal has been described as just even with the surface of the sea, which breaks upon it with great violence. The bottom about it is rocky, and swarms with fish. Its extent from North to South is about a mile.

From the centre of the reef the North point of Bonavista bears N.E. ½ N. (*N.* 26° *E.*) 9½ leagues, and the South point of the same E. by N. (*N.* 64° *E.*) 7 leagues.

This danger appears to be on the central part of an extensive bank of coral soundings, extending over 4 or 5 miles to the southward, and considerably to the eastward and westward. Some ships had soundings of 25 to 50 fathoms to the West and S.W. of the reef, at from 2 to 5 miles from the breakers. Immediately after striking, the *Lord Melville* had 25 fathoms, her head being to the eastward; shortly after, 30 fathoms. This ship hove-to, with her head easterly, until daylight, and had from 30 to 40 fathoms, all coral soundings. Others had soundings 10 or 12 miles to the southward of the reef, generally coral, sometimes intermixed with sand and shells, and not less than 20 fathoms. The mean of the observations and chronometers of the fleet gave 15° 49′ N., and 23° 14′ W., as the situation of the reef, which is on the meridian of the Isle of Mayo; its situation, according to the Admiralty survey, is 15° 41′ N., and 23° 13′ W.

ISLE OF MAYO.—This island is raised considerably above the sea, but a great part is level, excepting three inland mountains of considerable height; but these show as hummocks, and are not conspicuous. On the S.W. side is a sandy bay, called English Road, within which is the town and extensive salt-pans. The soil of this isle is generally dry and unproductive, and there is but one spring of water in the island. The coast is, however, plentifully stocked with fish, which supply, with a few vegetable productions, subsistence to the poor inhabitants.

From the S.W. end of Bonavista to the Island of Mayo, the course is S.W. by S., distant 15 leagues; Mayo is about 4 leagues in length from North to South, rising most toward the middle. On approaching the island from the S.E., the appearance is very different; you may descry, in the North part, two hummocks, which appear like two islands; but, when nearer, the land is perceived by which they are connected. Southward of these is a mountain (*Monte Maio*), with very low ground to the South, over which two hillocks are seen.

At half a league from the middle of the North side of the island is a dangerous reef, the *Galhao*, extending N.N.E. and S.S.W. three-quarters of a mile, which must be cautiously avoided.

In English Road ships may anchor in 7 or 8 fathoms of water. The landing is very indifferent, no good water to be had, and the place is quite defenceless. The shore to the eastward of and abreast the town is steep, bluff, and rocky; but, to the westward, a low white sandy beach extends to a rounding point, from which a spit of sand and coral stretches outward, at a short distance from the extremity of which there is no ground at 45 fathoms. The spit may be rounded in about 16 fathoms, and a ship could not anchor further out than in that depth, the edge of the bank being steep. At half a mile West from the town there is anchorage in 12 fathoms, latitude, according to particular plan, 15° 16′ 10″, long. 23° 15′. By general chart, 15° 7′ 30″ N., and 23° 17′ W.

ST. IAGO.—Ships running from Bonavista to St. Iago, and being obliged to ply to windward during the night, must be cautious how they approach Maio, on account of the reef before mentioned off the North point of that island; having doubled that point, they may steer S.W. to make the land of St. Iago, and thence southward until they make the Road of Praya the common place of anchorage, which may be known at night by the lights presently described.

The land of St. Iago is very high, the peak of San Antonio, the highest point of the ridge, being 4,720 ft., and the eastern coast is bordered with rocks, lying very near the land, along which you may sail very safely, at the distance of 2 miles. The S.E. part, which is in reality the *East* point, appears as a long low point, when you are to the northward or southward of it; and from this point, *S. W. by S. true*, about 6 miles, lies the East point of Porto Praya. Between the two, and near the former, lies a bay, which so much resembles that of Porto Praya, that many vessels, deceived by the likeness, have run the hazard of being lost in this dangerous place; at the bottom of it are several cocoa-nut trees, and a few houses. The land between this and the point of Porto Praya is mostly perpendicular, appearing, in some places, like the *Berry Head*, in Torbay; and though the fort of Port Praya, which stands on a small cliff, is a mark by which the true bay may be distinguished from the false one, yet the surest mark is, that the North or East point of the false bay is surrounded with breakers; whereas the point of Porto Praya is high, steep, and free from shoals. You must haul close round the point, and keep within a cable's length of the shore to go to the anchoring-place. It may also be noticed that there is a look-out on the cliff, at half a league to the northward of the entrance of Porto Praya.

Porto Praya is a fine bay, which lies between two points, bearing from each other *W. by S.* and *E. by N., true*, about 1½ mile. As you sail round the East point, you will soon open the forts at the bottom of the bay, to the westward of which, in a valley, are several cocoa-nut trees and several houses.

The *Coaling Station* is on the inside of Quails or St. Marie Islet, which is 1 mile from the town of Praya.

"The anchorage is well sheltered, and has a depth of water of from 5 to 7 fathoms. There is an admirably-managed free hospital at Praya; and the island of St. Jago abounds in sweet potatoes, cabbages, pumpkins, and a variety of fruits, such as oranges, lemons, and bananas. Drinking water is good, and can be put alongside ships at the rate of 8s. per 100 gallons. The

population of St. Jago is over 30,000, and the island is extensively cultivated. It exports produce to St. Vincent and other islands adjacent. The port charges on vessels calling for refreshments only is said to be 5 dollars for a 'health visit.' The only drawback to the port is that there is no dock for the repair of vessels; but this will doubtless be met as the shipping trade increases."—*Liverpool Telegraph, December*, 1874.

The sandy cove, on the East side of the bay, is an excellent place to haul the seine in, as is also the head of the bay. The principal fish are the mullet (gray and red), rock-fish, snappers, cavalla, and a variety of small fish.

St. Marie, or *Quails*, or *Frenchman's Island*, on the western side of the bay, is a small black island, almost even to the top, but rugged at each end, and some rocks lie off each end to about half a cable's length; there is also a rocky ledge off the North end, where the water is, in general, shallow. You will not have more than 3 fathoms of water between this and the fort; inside, or to the westward of the island, it is navigable for boats only, and on the western side of the island the *coaling station* is situated.

Lights.—On the South point of Quail Island a *fixed bright light* is shown, elevated 85 ft. above high water, visible in clear weather 5 or 6 miles. The light tower is white, 14 ft. high, and surmounted by an iron tripod, the top of which is 41 ft. above the ground. On the North point of Quail Island a *fixed red light* is shown, elevated 65 ft. above high water, which in clear weather should be visible 1 or 2 miles. The lantern is on the roof of a red house, 23 ft. high, standing between two detached buildings. On the Mole of Praya, at the new landing place, is a small *red light*, visible only a short distance.

Caution.—These lights are the property of a private company, and cannot always be depended upon.

Commander Dunsterville says:—"This island, bearing W.N.W. ½ W. 8 leagues, appears very high. *Mount St. Antonio*, rising out of its centre, is of a conical form, and terminates in a peak, which peak, bearing N.N.W. (by compass) leads to Porto Praya Road; and, as you advance westward, you will see the East end, which is very low. As a further guide, you will see an opening, several miles north-eastward of the harbour, on *Signal-post Hill*, which gradually slopes to the westward; also *Red Hill*, which is on the port side of the bay, N. by W.

"The town is situated on an eminence rather high, and perfectly white, the houses being visible from S. by E. to S.W. by W.

"In sailing into the bay, keep well to the eastward, as the ground to the westward is foul. Anchor in from 10 to 7 fathoms, with Red Hill W. by N., outer eastern entrance E.S.E."

"Quail Island, though centrally situated, is too near the main land to assist any one in finding the anchorage. Do not approach it, on any point, nearer than half a mile, as the vicinity is rocky, and some rocks do not appear above the surface."

A visitor, in 1852, complains of the want of clearness in the directions for Porto Praya, as he says there is some confusion in the names of the S.E. and East points. The *East* point is that to the North of St. Francis Bay, and the S.E. point is that on the East side of Porto Praya. The peaks which

are sometimes pointed out as good marks, are so frequently obscured by haze as to be of little service. He therefore suggests the following brief directions as sufficient:—After making the Island of St. Iago (outward bound), steer to the S.W. till the South extreme of the road bears W. by N., when the South point will be distinctly in view, having Red Hill behind upon the same bearing; haul up then to the westward, and pass the point about three-quarters of a mile off. Quail Island (having a very black appearance) will then be seen to the N.W.; steer up for the North end of it till you fairly open the bay; then luff up to about N.N.W., and anchor midway between Quail Island and the eastern shore of the bay, in 7 fathoms, leaving Red Hill just open to the northward of the island.

The best anchorage is, to bring the flagstaff on the fort N.W. by N. (*N.W.*) about three-quarters of a mile, the body of Quail Island West, and the point of the bay opposite Quail Island E. by S., in 7 and 8 fathoms. Many commanders prefer anchoring nearer the N.E. side of the bay than the Isle of Quails, for the sake of more easily getting under sail, without running the risk of being carried by the currents upon the points of rocks to leeward, before the vessel has gained fresh way enough to steer clear of them; and it has been observed that vessels may anchor anywhere in the bay, from 9 to 11 fathoms, good bottom, but nearer to the eastern shore than to the Isle of Quails, as the wind, except in the months of August, September, and October, generally blows from the N.E.

The Bay of Praya, being under the South end of St. Iago, should you be to the leeward of it, you will find it difficult in beating to windward against so strong a current as there is here.

To those bound from Praya Bay to Bonavista, Mr. Keilor recommends that they should endeavour to sail in the evening, as the current will be favourable. He adds: Do not stand too far over toward the African shore, nor work between Mayo and St. Iago, and you will find the ship get to the eastward very fast.

Winds.—Capt. FitzRoy, who visited this place in H.M.S. *Beagle*, January, 1832, made the following observations:—

"The wind being always from the North or East during this season of the year (December to June), a ship can moor as close to the weather shore as may be convenient; but during July, August, September, and October, no vessel should deem the bay secure, or anchor near the shore, because southerly gales sometimes blow with great strength, and the *rollers*, or heavy seas sent in by them, are dangerous to ships which have bad ground tackle, or are lying near the land. As I have myself experienced the force of these gales, in the vicinity of the Cape Verde Islands, and witnessed the sea raised by them, I can confidently warn those who are inclined to be incredulous about a gale of wind being found in 15° of North latitude, beyond the limits of the hurricane regions.

"Strong gusts come over the land into the bay during the fine season, when the breeze is fresh; therefore, a ship entering with intent to anchor, ought to have a reef in her topsails, and be ready to clew up the top-gallant sails at a moment's warning.

"From August to October is the rainy and sickly season. In September, a S.W. gale is usually experienced; but from five to ten hours before its

commencement, a dark bank of clouds is seen in the southern horizon, which is a sure forerunner of the gale. Should a vessel be at anchor in the port at such a time, she ought to weigh and put to sea until the storm has ceased, and the swell subsided. In the month of September preceding our visit, an American merchant brig and a Portuguese slaver were at anchor in Port Praya. A bank of clouds were seen during the day in the S.W., and the American went to sea; but the slaver remained at anchor. A storm arose at night, drove the slave-vessel ashore, and dashed her to pieces in less than half an hour, yet did the American no danger whatever, and the next day she anchored again in the port.

"Except during the rainy season, the wind is always north-easterly, and then the sky is clear and the sun very powerful; but a dry haze hangs over the island in a peculiar manner, and a quantity of fine dust, quite an impalpable powder, frequently settles on every exposed surface, even on the sails and rigging of a vessel, when passing near the islands."

In settled weather, there are often regular land and sea breezes in the bay —the sea breeze setting in near noon, with a great surf on the shore, and ending at 4 or 5 o'clock in the afternoon. The N.E. wind sets in toward evening, and continues during the night.

Santiago, or *Ribeira Grande*, commonly called *La Cidade*, stands at the bottom of a ravine at 6 miles to the West of Praya. Vessels of any size can anchor before it in the fine season. The best place is said to be with the fort flagstaff in one with the episcopal palace. From hence to the S.W. point of St. Iago there is no anchorage; between this and the North point of the island, *Ponta Bighuda*, there are *Ribeira Barca* and *Ribeira Prata*. These two beaches are 6 miles apart, and between them is a projecting point, near which are some houses. Water may be got at these anchoring places in the fine season. *Tarrafal Bay*, on the same coast, is about 6 miles North of Ribeira Prata. It is large, and, according to the people of the place, safe at all seasons. There are no houses except a custom-house post, but provisions and water are brought down from the interior.

Point Bighuda is very high and abrupt, and is 3 miles North of Tarrafal Bay. The eastern side of St. Iago is dangerous from the calms produced by the high lands, which reflect the N.E. winds, and by the currents and bad sea which are found on it. The only place worth mentioning is the little harbour of *Santiago*, which will scarcely hold four vessels of 100 tons. It lies about the middle of the coast, and may be known by some clumps of cocoa-nut trees and a small church to the South.

FOGO, or Fuego.—This island, much higher than any other of the Cape Verde Islands, is only a continued mountain, rising into a peak of 9,760 ft. in height, which has been in activity in recent times. This island has, nevertheless, about 7,500 inhabitants, which the eruptions of the volcano have forced sometimes to quit the island. The ground is clear within a mile of the shore, on the N.W., West, and South parts; but on the S.E., East, and N.E. parts, it is rocky. At about 4 miles from the North end of Fogo, it is said, there lies a rock, with 12 or 14 ft. of water on it, over which the sea breaks when it blows hard, but not else, and the bottom is clean all round it; but its existence is questionable.

The town is that of *Nossa Senhora da Luz*, on the western side. The roadstead is open, and the anchoring ground off the town very close in, being only half a mile from the shore. In 25 fathoms, rocky bottom, the northern extremity bears N. 15° E. (*N.* 4° *W.*); the southern extremity, S. 68° E.; the northern flagstaff, N. 31° E.; the southern, N. 21° E.

No other soundings are to be obtained near either Fogo or Brava, with a line of 130 fathoms, at three-quarters of a mile from shore.

The marks, says Mr. Keilor, when a brig was at anchor off the town, in 10 fathoms of water, were the town bearing E. by N., a quarter of a mile; the mount, E.N.E.; the South end of Brava, S.E. by S. The bay is open, with foul ground, and a bad landing for boats. Corn, fruit, and cattle may be purchased at Fogo, but water is scarce.

BRAVA.—Brava is very high, and might be seen at a great distance, were it not constantly covered by a dense atmosphere. Its climate is temperate and healthy, and for this reason the Governor of the islands sometimes resides here. The winds here prevail at N.E. or East, most part of the year, excepting in July, August, and September. The channel between Fogo and Brava is 9 leagues in breadth. Five miles to the N.N.E. of Brava are the *Rombos* or *Romes*, two small rocky isles, nearly connected by smaller rocks, forming a crescent. The westernmost isle is lofty, and has a peak on it. Between these islets and the North end of Brava is a clear passage. The boat landings are bad, except in the harbour on the N.E. side of the island. Corn, live stock, and fruit, may be obtained.

Although Brava is very high, its mountains rising one above the other, like pyramids, yet being so near the Isle of Fogo it seems, in comparison, to be but low. It produces plenty of salt, and abounds most with saltpetre of any of the islands. According to Captain Roberts, it has several bays or roads, where a ship may anchor, the best of which, called *Furna*, or the *Oven*, lies toward the N.E. end of the island; if you haul in near the rock, which is a very good quay, having water enough by the side for a large steamer, you will lie land-locked from all winds; nor does any wind blow in there, except from the S. by E. to the S.W., which heaves a sea into the bay, and makes it very well deserve the name of a harbour.

ST. NICOLAS.—The land is high, and the coasts, therefore, subject to heavy squalls, &c.

There are two remarkable mountains which may be seen from a distance of 15 leagues—one in the shape of a sugar-loaf, called the *Peak of Trade*, which is near the middle of the island; the other, *Monte Gordo*, near the West end.

From English Road, in Bonavista, to the East point of St. Nicolas, the *true* bearing is W.N.W., and the distance 22 leagues; the course must be regulated according to the set of the sea. The East end of the island may be known by its being a platform point, having a pyramidal rock, which appears like a sail, at a short distance.

On the South side, at 1½ league from this end of the island, is a bay, having a black sandy beach and a pond of fresh water, supplied from the mountains, and hence called, by the English *Freshwater Bay*, properly *Preguizo Bay*. To anchor in this bay, shut all the land to the eastward within the East point of the bay; you will then lie in 7 fathoms of water, within

half a mile from the shore. There is good landing for the boats, with plenty of good water in fine weather, and at neap tides; for, as the tides rise here 5 or 6 ft. on the new and full moon, the pond is then overflowed. At this time you are subject to heavy squalls; and, notwithstanding the wind blows off shore, the sea is very high close to the beach.

At about 4 leagues to the westward, from the middle of Freshwater Bay, lies *San Jorge* or *St. George's Bay*, where a ship can get refreshments; but there is no water. This bay is known by a sugar-loaf mount, and a flagstaff on the hill above the bay. There is tolerably good anchoring in 7 fathoms close to the shore; but without that depth, or in 9 or 10 fathoms, the ground is rocky. There is a shelf stretching S.E. by S. from the N.E. point of the bay, on which less water is found than within it; so that, should your anchor start, which will happen if you are not careful, the bank being very steep, and the squalls very sudden, it may hook this shelf and be lost. The marks to anchor are the cove or landing-place for boats, N.W., distant a quarter of a mile; Sugar-Loaf Mount N.E. by E., and the flagstaff N.W. by N.

Terrafal Bay.—On the S.W. side of St. Nicolas is Terrafal Bay, where you may anchor in from 20 to 10 fathoms, with the coast to the southward bearing S. by E., and the Islands Raza and Branco in a line bearing N.W. $\frac{3}{4}$ W. (*W.N.W.* $\frac{1}{2}$ *W.*) and the landing-place East, a quarter of a mile.

The custom-house is situate on the S.E. angle or corner of this bay. From this to the West point of St. Nicolas there is a bank of soundings, with from 40 to 20 and 35 fathoms at half a mile from shore. In the last depth is anchorage, in sandy ground, at a mile S. by W. from the West point, but sheltered only from the N.E.

There is in Terrafal Bay, a high bluff rocky point, nearly a quarter of a mile short of the sea-side; in which place it is low, stony, gravelly, and in some places, shingly ground, the shore being a pebbly beach. On each side of this point is a very deep gully, out of which come violent flaws or gusts of wind; and, therefore, when anything of a hard gale blows, it is very difficult to turn up into this bay. To avoid these flaws, you must anchor right against the point, between the gullies, where you may ride very easy under its lee, in from 16 to 3 fathoms.

Within the bay the depths are 12, 13, and 14 fathoms, soft ground; and then they shoalen gradually to the shore, to the depths of 4 to 5 fathoms, where you have again sand to the pebbly beach. The only anchorages are on the South side of the island. The northern coast is not frequented.

By digging a well, almost anywhere on the low land, you may water here, unless the rainy season has failed; but there is always water in the valley, about half a mile from the sea, whence the natives will bring it down on asses for a trifle. From this road you may see in clear weather all the leeward islands; but if it be in the least hazy the Isle Raza is not discernible.

RAZA, BRANCO, and STA. LUCIA.—These islands lie between those of St. Nicolas and St. Vincent, as shown on the charts. Rugged and mountainous, they partake of the general character of the other islands. *Raza* lies *true* West 8 miles from the West point of St. Nicolas, and appears in

the old charts under the name of *Chaon* or *Dog's Isle*. It is nearly 2 miles long from East to West, and 1½ broad. The landing-place is under the N.W. point, facing the West. This island is low and uninhabited. The edge of its coast is steep and rocky, and landing is difficult when there is any wind. Between it and Branco, at about one-third from Raza, is a coral reef, extending S.S.W. and N.N.E., and having on its shallow part 6 fathoms of water, but deepening gradually on the West to 15, and on the East to 18 and 20 fathoms. The sea continually breaks over the reef, owing to a strong tide or current setting through between the isles.

Branco, the Redonda of the old charts, is a league to the N.W. of Raza, and much higher. In the passage between are soundings of 6 to 18 in the middle, and decreasing near Branco to 7 fathoms. The latter is a narrow island, 2½ miles long from S.E. to N.W. A spit of sand stretches from its S.E. end, on which the seas are violent, and its shore is altogether rocky.

Praya Branca, on the N.W. side of the island, has a small village of about thirty stone-built houses, thatched with reeds. The scenery here, being on the side of a stupendous mountain, is picturesque and magnificent. A small stream of water supplies the village; bananas and papayas are planted on the borders of the brook; cassada and vines on the banks of the valley. The bread is made from maize, or Indian corn, and from farinha, or flour of cassada. The natives are, in general, poor, but very courteous.

Monte Gordo is in the central part of the island, toward the West. Its summit is 4,200 ft. above the level of the sea. The mountain is composed entirely of volcanic matter, very fragile and porous, and does not form a peak like many of the smaller ones on the island. It is well clothed with vegetation, even to the summit. The *Euphorbium balsamifera* flourishes to about 3,700 ft. above the level of the sea. The prospect hence is very extensive, calm, and beautiful.--*Mr. Forbes: Capt. Owen*, vol. i., p. 27.

St. Lucia lies at the distance of 3½ miles to the northward of Branco, and the Bank of Soundings extends to this island. The bank here forms a regular flat of 10 to 13 fathoms. The South coast trends nearly East and West 4 miles, and in the middle of it is a good landing-place. A steep bank, half a mile broad, stretches from it, having on its edge 2 to 4 fathoms. In the bay formed by the S.W. coast are the ruins of a village, at three-quarters of a mile from the South point. To the westward of this is a little islet named *Leon*. The N.W. part of St. Lucia is high mountains.

Capt. Bartholomew describes St. Lucia as of moderate height, with a bay on the S.W., where small vessels may anchor, being sheltered from all points but South and S.E. The beach is sandy; the anchorage, small pebbles and sand. In the middle of the bay is an islet, named *Leon*, with the ruins of a village on it, and frequented by fishermen only. There are many turtle here, and much orchilla is gathered, with some cotton, in a wild state.

The passage between St. Lucia and St. Vincent is named *Foul Channel*. In Foul Channel, when blowing fresh, and the tide setting to windward, it bears the appearance of shoal water, but H.M.S. *Leven* beat through, and did not find less than 6 fathoms, with 15 fathoms in mid-channel.

SAN VICENTE, or St. Vincent's.— The island of St. Vincent is separated by a channel, 4 miles broad, from that of St. Lucia, and by one of 7 miles from that of St. Antonio. This island is 11 miles long, from East to West,

and about 6 broad. It has two chains of mountains, the N.E. and S.W which form a central valley that terminates in the bay called *Porto Grande*, upon the N.W. side of the island. The N.E. coast forms two bays, separated by a low peninsula, of 2 miles on either side, and this coast has been described as altogether dangerous.

The general aspect of it is mountainous, with sharp peaks; the coast is rocky, and rises abruptly, but tide, ebbing, leaves a sandy beach. No doubt can be entertained that the general character of the island is volcanic; the interior is formed by ranges of hills of different heights. The surface of the country is undulating, and in the interior and loftier parts has a tendency to table lands.

With regard to the physical divisions of the island, it is divided by a valley running from West to East; in the southern division one range of mountains proceeds from West to East; another from North to South, but both connected by a hill. The northern part of the island consists of mountain chains lying N.E. and S.W., and N.W. and S.E.

The water runs from the elevated parts to the sea coast, and loses itself in the sand, but the quantity of it is not capable to form in the dry season a river; the principal valley is divided by a hill, which connects the northern and southern division. The watercourse, running West, takes its rise 520 feet above the level of the sea; the bed is gravel, covered with mud, united by chalk. The coast forms a great number of little bays, in general capable of containing vessels; the chief port is named Porto Grande, situated on the West side of the island, and is a good anchorage for about 300 vessels; water and provisions cannot easily be procured; the former defect might be remedied. The wind blows generally from the N.E.; in the rainy season, which commences in the month of July, and ends on the 15th of October, the S.E. wind prevails. During the last years the rains have been regular in point of time but sometimes not in quantity.

The *telegraph cable*, joining Brazil with Europe, and touching here and at Madeira, leaves the island from a building situated on the shores of the bay next northward of that in which the town is situated. One portion extends from this building in a N.W. by N. direction, and then N.N.W. to a position midway between Ribeira Julian Point and Bird Island, and thence passes away to the westward. The European cable, from a position about a mile N.W. by N. of the cable house, thence trends away to the northeastward.

Porto Grande is the largest and best bay in the Cape Verde Islands; it is capable of holding 300 sail of large ships, well sheltered under the high lands, and has a fine appearance.

Porto Grande is the port of call for mail steamers to and from South America, and the West Coast of Africa, as well as for men-of-war, that can be furnished with coal in large quantities, at the rate of 18 tons per hour, from iron barges holding about 20 tons each, towed by steam launches. Other supplies may be had to a moderate extent. The price of fresh beef is 7*d.* per pound, and vegetables 3*d.* per pound. Water may be purchased at $\frac{3}{4}d.$ per gallon, but steam vessels would probably find it

cheaper to distil their own. It is also the residence of Her Majesty's Consul.*

Porto Grande bay is situated at the north-west side of St. Vincent; it is 2 miles wide at the entrance, the points bearing E.N.E. and W.S.W. from each other, and one mile and a half deep. Between the points of entrance the depth is even with 24 fathoms in the centre, shoaling gradually on the west side to 9 fathoms half a cable from the shore; but to the eastward there are 17 fathoms within 80 yards of the rocks. In the centre of the bay the depth is 10 fathoms, shoaling gradually in all directions towards the shore, the Orontes bank being the only obstruction, with 21 feet on it.

There is ample anchorage ground, sheltered from all quarters. During the N.E. trade violent squalls are of frequent occurrence, and ships should always be prepared with a second anchor in case of parting, or drifting. Moorings are laid down in 5 fathoms, half a mile W. by N. ½ N. from the coaling jetties. Vessels of 15 feet draught may anchor at 3 cables and a half from the shore, but vessels of large draught are recommended to anchor outside or westward of the buoy to avoid the Orontes bank, of 21 feet. A good berth for a large ship is in 10 fathoms gravel, Bird island bearing North, fort E.S.E.

In coming into Porto Grande under sail, shorten sail in time, and look out for heavy gusts over the high land. If in want of coal, a berth should be picked up as near the buoys as possible, where the water is smoother and the squalls less felt.

Going into Porto Grande at night the high land all around is very deceptive, and Bird island is the only guide; it always shows clearly and distinctly, even on the darkest nights. After passing Bird island, bring it to bear N. by W., and anchor on that bearing in 6 fathoms, sand, the west point of the bay bearing W. by N.

Orontes Bank, of about half a cable in extent, with 21 feet water on it, lies, W. ¼ N. 5 cables from the northern coal jetty; and from it the mooring buoy, distant one cable, is in line with the east point of the bay, bearing N. by E. ½ E.

Bird Island is 600 yards long north and south, and 150 yards broad; it lies without the entrance of the bay at nearly three-quarters of a mile from its N.W. point. The island is rocky, 273 feet high, and appears conical. You may pass it on either side.

It is high water, full and change, at Porto Grande at 7h.; springs range about 5 feet.

Ships should moor with a kedge, as a very strong current commonly sets to the N.E. between Bird Island and the shore, and, as the N.E. wind is variable, at night it is impossible to keep a clear anchor without this precaution; for the wind at times comes in strong gusts from off the land."†

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* In 1874, the Portuguese Government proposed to erect two lighthouses for the convenience of the increased number of vessels visiting the port.

† In working between St. Antonio and St. Vincent, to Porto Grande, you may stand to a mile off St. Antonio, and as near as you please to St. Vincent, as the current generally sets strongly through to the N.E.—*R. Keilor.*

Mr. Finlaison adds, "In running between St. Antonio and St. Vincent we sounded in 42 fathoms, bits of coral mixed with sand and small stones. Within half a mile of Bird Island we had 42 fathoms.

"Having proceeded about 8 miles to the southward of St. Vincent, 40 fathoms of water were found; and on approaching *Still Bay*, at the S.W. side of the island, found regular soundings, ooze and sand, to 20 fathoms, nearly in the centre of that bay. We anchored in this depth, with the West point of the bay W. by N., and its East point E.S.E.; the distance between the two points is 2½ miles; regular soundings from the ship to the shore, and very good landing on the beach."

Captain Bartholomew describes the bay on the S.W. side as the *Bay of S. Pedro*, having a fine sandy beach, and he says that vessels may anchor in 10 fathoms near the middle of the bay, or rather more to the westward. The anchorage is good in the dry season, and the inhabitants say there is plenty of wood and water. The American whalers frequent this place.

On the eastern side of the island is another anchorage, the *Praya da Gatta*, with a sandy beach, and he says that vessels may anchor in 6 fathoms; the bottom is clear, but a sea sets directly in when the wind is either N.E. or S.E., the Island of Sta. Lucia sheltering between these points. This bay and coast are without wood, water, and inhabitants.

ST. ANTONIO.—This island, as already shown, lies at the distance of 8 miles to the N.W. of St. Vincent and it appears altogether like an assemblage of high mountains, particularly to the West. It is 22 miles in length from East to West, and about 11 in breadth, and its highest peak is estimated at 7,100 ft. above the level of the sea. There is no anchorage.

Of the two highest mountains in the West, the *Sugar-Loaf* is the most elevated, and both are commonly covered with clouds. According to the Admiralty survey the Sugar-Loaf stands in 17° 4′ N., and 25° 20½′ W. The island is very woody, but has plenty of goats, fruits, and salt; it produces wine, cotton, indigo, &c. There is a village, *Santa Cruz*, on its S.E. side, but the ground is not fit for anchorage.

Terrafal Bay is only half a league to the northward of the S.W. end of the island. The edge of the bank, with 40 fathoms, is about one-third of a mile from shore. At a cable's length within are 50 fathoms, and it then shoalens inward to 20, 8, and 4 fathoms; the latter near the beach. Latitude of the landing and watering-place, 16° 57′, long. 25° 24′ 48″.

"This watering-place of Terrafal Bay is one of the most convenient for the purpose amongst the Cape Verde Islands. The bay is spacious, and has a black sandy bottom. Vessels anchor in 20 fathoms, at three-quarters of a cable's length from the shore, sheltered from the N.E., and South winds and sea; and when the wind comes to the westward of South or North there is always, from the extreme high land, a calm in the bay, the wind never blowing home, but only occasioning a swell to set in.

"From the high mountains over the bay a small stream descends, which is never dry; on the first level spot a large pond has been formed as a reser-

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Mr. Finlaison says that ships bound through this channel should keep over toward the latter, as no danger whatever is to be apprehended on that side.

voir to receive the stream, with a sluice to conduct it to the sands between the flat and the beach, which is a gradual descent; the flat may be about 60 or 70 ft. above the level of the sea, and is generally moist and cool. In the vicinity of the pool is a fine plantation of bananas, papayas, &c., and in the lower sandy grounds a cotton plantation with some trees of the *asclepias procera*. Just above the beach is a well; and when the water is let off from the pool, all the soil between it and the well must be saturated before any can arrive at the latter.

8.—BERMUDAS OR SOMERS ISLANDS.

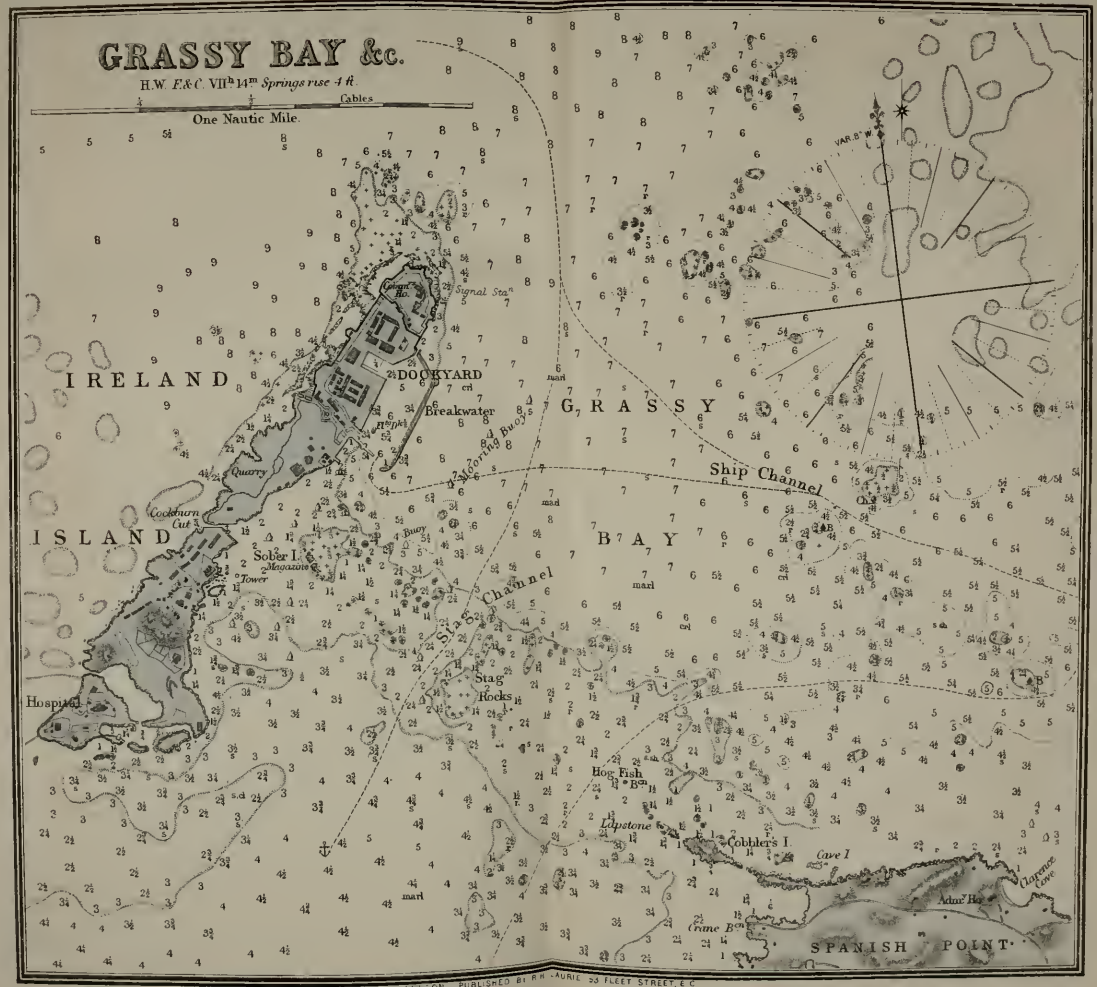
These islands, and the surrounding reef, are of an oval form, the longest diameter lying N.E. by E. and S.W. by W. 25 miles, and the breadth 10 to 12 nautic miles. The islands themselves are on the S.E. side of the reef, and are shaped in the most irregular manner imaginable; they extend about 15 miles in length in the general direction of the reef given above. The breadth is very various, the greatest about 1½ miles. The chief islands are Bermuda, containing the town of *Hamilton*, St. George's, with its town of the same name, Somerset Island, and Ireland Island, on which is the dockyard; these are the principal: besides these are St. Davids, Longbird, Paget's, Smith's, Cooper's, Nonsuch, Castle, and many inferior islands and rocks.

The following general description is extracted from that by Sir Wyville Thomson, the well known naturalist of the *Challenger* Expedition. The paper in full, containing other useful and interesting information, will be found in the numbers of "Good Words" for February and March, 1874. The stay of H.M.S. *Challenger* lasted 36 days at the islands.

History, etc.—Bermudas or "Somers," or, by corruption, "The Summer Islands," seem to have been discovered about the year 1503, by Juan Bermudez, a Spaniard, in the vessel *La Garza*. About 100 years later, the *Sea Adventure*, one of a small fleet dispatched from London to convey the newly-appointed Governor, Sir Thomas Gates, Admiral Sir George Somers, and some other officials to the young colony of Virginia, reckoning themselves, on Monday, July 24th, 1609, St. James's day, within seven or eight days' sail of Cape Henry, "the clouds began to thicken around, and a dreadful storm commenced from the N.E., which, swelling and roaring as it were by fits, at length seemed to extinguish all the light of heaven and leave utter darkness. The blackness of the sky and the howling of the winds were such as to inspire the boldest of our men with terror, for the dread of death is always more terrible at sea, as no situation is so entirely destitute of comfort or relief as one of danger there."

After seeing St. Elmo's fires on the rigging, springing a leak, and undergoing every possible trial, moral and physical, for five days, Sir George Somers at length sighted land, and the wind, lulling a little, they ran their ship ashore, where she became a complete wreck.

Early in May, 1610, however, Sir George Somers had completed a pinnace, the *Patience*, and on the 10th of May the little party set out, and


GRASSY BAY &c.
H.W. F.& C. VII^h 14^m Springs rise 4 ft.
Cables
One Nautic Mile.
VAR 8° W
IRELAND
ISLAND
DOCKYARD
Breakwater
Signal Stn
Quarry
Cockburn Cut
Sober I.
Tower
Hospital
GRASSY
BAY
Ship Channel
Channel
Stag Rocks
Hog Fish B^y
Lipstone
Cobbler's I
Cave I
Adm^l Bay
Crane Bay
SPANISH POINT
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about midnight of the 18th they "were sensible of a charming odour from the land resembling that from the coast of Spain, near the Straits of Gibraltar." They reached Fort Algernon in safety, but they found the Virginian colony so badly off for provisions that Sir George Somers volunteered to return to Bermudas for supplies; and during the trip he died near the site of the present town, St. George's, where there is a monument erected to his memory. His nephew, Capt. Matthew Somers, carried his uncle's body to England in the old cedar pinnace. Owing to Captain Somers' representations a company was formed in England to colonise Bermudas, and in 1612 the first party of settlers arrived under the charge of Governor Richard More. Since that time Bermudas has been a British colony, though perhaps not a very successful one, and latterly an important naval and military station.

The defences of these islands demonstrates the great importance attached by the parent country to this colony as a place of refuge for merchant ships in time of war, a rallying point for our navy, a depot for provisions and naval stores, and a sheltered security for refitting and repairing vessels of almost any size. An enormous iron floating dry-dock was added by the Government, in 1869, to the resources of the islands.

Approaching the islands the land appears low, rising nowhere to a height greater than 260 ft., and by far the greater part forming gentle undulations at a height of from 20 to 60 ft. above the sea level.

The composition of the islands being white granular limestone, it absorbs the sea water, and if a well be sunk in almost any part of the islands it is filled with water at once, but it is only the upper layer which is fresh. The water at the bottom of the well is brackish, and is affected by the tide, and the fresh water, which is merely the rain-catch of the surrounding ground, lies on its surface. As there is always a certain amount of mixture, the wells do not yield good drinking water, and the people trust greatly to their rain-water tanks. It has become an almost universal custom to roof the houses with thin slabs of white limestone, and, further, to whitewash both roof and walls. The rain-water collected on the roof, and kept clean and fresh by the constantly renewed whitewash, is carefully led into a tank, and forms the only supply of pure water.

Productions.—There is little live stock on the islands; cattle and sheep do not thrive well, probably mainly owing to the want of a plentiful supply of good water. Butcher meat is almost all imported from America. Horses are not very numerous, and only tolerably good. There are a few mules and asses. The principal crops raised are early vegetables for the New York and other markets, which cause a brisk business in the months of April, May, and June. Arrowroot—the starch of *Maranta arundinacea*—is excellent, and fetches a much higher price than the West Indian arrowroot, which is driving it out of the market. Bermudas was famous for its oranges, but about the year 1854 a minute insect of the family *Coccidæ* appeared on the orange-trees, and multiplied infinitely. The leaves, covered with scales, and glutinous with a viscid excretion from the animal, became yellow and fell off, the fruit dropped before ripening, and finally many of the trees died. Bermudas has never recovered from this plague, and now there is scarcely

an orange grown on the islands. Fruit is by no means abundant. The smaller English fruits—gooseberry, raspberry, currant, &c.—run to wood, and do not bear. Strawberries fruit fairly. Bananas are very generally cultivated, and are good, though the varieties are not so carefully selected as they are in Madeira. The value of the agricultural exports, in 1866, was £17,960; in 1872, £64,030, a surprising increase.

The civil population of Bermudas in 1876 was estimated to number 5,092 white, and 8,326 coloured people. Seamen and marines numbered about 900. The coloured element in Bermudas is by no means entirely African. In the earlier days of the settlement many labourers and slaves were brought from Virginia and other parts of North America; and one may often recognise the aquiline nose and characteristic features of the North American Indian, now, however, except in one or two families, very much marked by negro intermixture.

The depth of water increases round the islands with extreme rapidity. Seven miles to the North there is a sounding of 1,375 fathoms, and about 2 miles farther off one of 1,775 fathoms. To the N.E. there is water of 1,500 fathoms at a distance of 10 miles, to the N.W. of 2,100 fathoms at a distance of 7 miles, and to the southward of 2,250 fathoms at 10 miles. The only direction in which there would seem to be a series of banks is along an extension of the axis of the reef to the S.W. H.M.S. *Challenger* anchored for a night in 30 fathoms water on this line about 20 miles from the edge of the reef, and a shoal is mentioned at a still greater distance in the same direction; about 300 miles farther on, however, a sounding is given of 2,950 fathoms The abruptness and isolation of this peak, which runs up a solitary cone to a height about equal to that of Mont Blanc, is certainly unusual; probably the most reasonable hypothesis may be that the kernel is a volcanic mountain comparable in character with Pico in the Azores, or the Peak of Teneriffe.

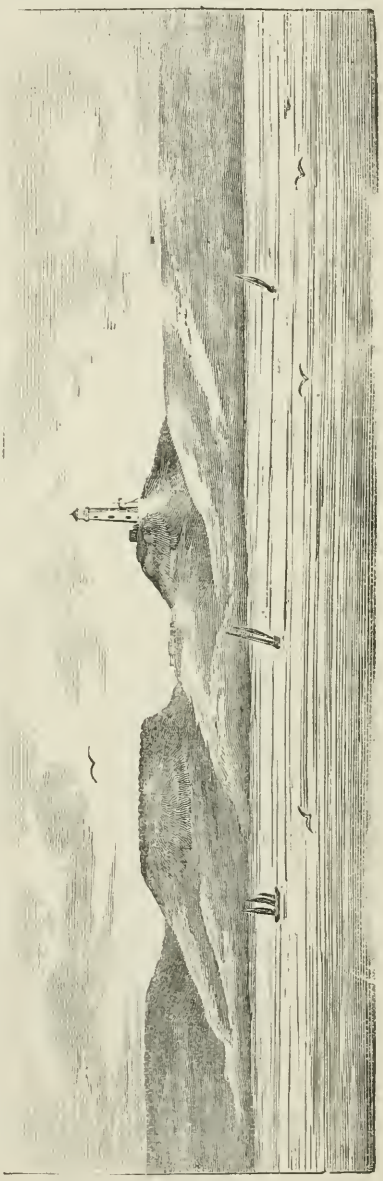
The Climate of Bermudas is very genial; the mean annual temperature is 70° F., while that of Madeira, in almost exactly the same latitude, is 65° F. This difference of 5° is due partly to the prevalence at Bermudas of S.W. winds blowing directly over the super-heated reflux of the equatorial current, and partly to the position of the islands within the region of the banked-down warm water of the Gulf Stream. The temperature of the coldest month (63° F.) is, however, somewhat lower at Bermudas than at Madeira (64° F.), while that of the warmest month is considerably higher (79° to 72° F.). This greater summer heat telling upon the flowering and the ripening of the seeds of plants gives the flora of Bermudas a more tropical character than that of Madeira.

Judging from General Lefroy's careful statistics, Bermudas cannot be regarded as an essentially unhealthy place, or as one possessing a climate unfavourable to the life of Europeans. The death-rate among the white population is about twenty-two in a thousand—nearly the same as the general death-rate of England, and the number of people of advanced age is large.

Hurricanes and tempests are very frequent, as is to be expected from the proximity of the isles to the variable limit of the Trade and other prevailing winds. Few autumns pass without hurricanes of more or less violence.

The *Bermuda Squalls* are sudden and violent tempests, occurring particularly in the winter season. As the day closes, the whole horizon becomes obscured by dark and heavy clouds, and the thunder and lightning which precede the first squall, give notice of its approach. After the commencement, the wind, continually shifting, blows in tremendous gusts at intervals of every 20 or 30 minutes, a dead calm intervening; and the sea, rising in confused and breaking waves, renders the situation of a vessel, particularly a small one, very dangerous.

The conduct pursued by seamen, and which appears to be the most advisable under such circumstances, is to furl the ship's sails, and endeavour to get before the wind; by which means she may ultimately run clear of these local squalls into a steady breeze. It is an observation made by seamen who are familiar with the Bermuda Islands, that the various winds which blow meet there and contend for superiority; and the inhabitants themselves remark, that the currents about their rocks are as variable as the winds, and numerous as their islets.



Gibb's Hill Lighthouse and Telegraph, on the S.W. coast, bearing N.E. by N.

LIGHTHOUSE.—The most useful mark to mariners is the *iron lighthouse* on Gibbs' Hill, on the South side of the island, in lat. 32° 15′ 0″ N., and long. 64° 51′ 40″ W., which shows a *revolving light*, visible every minute. It is elevated 362 ft. above the level of the sea; and in clear weather may be seen 21 miles off. It is higher than the adjoining land, and in day time the circular iron tower (which is 106 ft. high, and painted white), will appear like a sail. The light is obscured to the north-eastward by high land, between N.E. by E. $\frac{3}{4}$ E. and N.E. $\frac{1}{2}$ E.; but a small ray of light is visible in a N.E. direction over Mills' Breaker.

Bermuda is always approached with more safety from the southward; and in running for it at night, or in thick weather, care should be taken not to get to the northward of lat. 32° 3′ before seeing the light or the land.

In coming from the S.E. the light should not be brought to the southward of W. by S., or approached nearer than 6 or 7 miles during the night. Coming from the westward, it should not be approached nearer than 10 or 12 miles, until it bears to the northward of N.E. by E. With the light between N.E. and West, the coast is free from danger, and may be safely approached within 3 miles. Any vessel getting sight of the light from the northward had better haul off immediately, as the reefs extend all round from the S.W. to the North and N.E. from 15 to 16 miles.

The light will show a *bright flash*, continuing 6 or 8 seconds, and repeated once in every minute.

The situation of the lighthouse has been objected to by some, inasmuch as it is not visible at the chief entrance of St. George's. To remedy this a new lighthouse is now constructing at St. David's Head.

Signal Stations.—There are four signal stations on the islands. One on Fort George, at St. George's; central at Mount Langton, near the governor's house, near Hamilton; another on Gibb's Hill, near the lighthouse; and another at the dockyard, on Ireland Island. By means of these, signals are transmitted from one part of the islands to another, and vessels requiring pilots, &c., will be telegraphed to that effect.

The REEF.—This singular tract, extending 25 miles in length, N.E. by E. and S.W. by W., with a breadth of 10 or 12 miles, forms at once an effectual barrier against the fury of the Atlantic storms, and, with the exception of the few narrow and intricate entrances, an impenetrable line of reefs and breakers, over which no vessel can pass.

It is composed of whitish limestones and sandstones, in many parts as if composed entirely of minutely pounded shells, and calcareous clay, resembling pipe-clay. Upon this, coralline structures grew in innumerable patches, and in every variety. It is to this circumstance that the great danger in navigating within the reef consists.

The water on the reef is remarkably clear, so that even small objects are readily distinguishable at considerable depths. A dollar may be discerned at 16 or 18 ft.; and the appearance of the bottom, in many parts, and in clear weather, is very beautiful, from the varied growth and structure of the coralline productions. To this circumstance of the transparency of the water the pilots owe their talent of conducting vessels through the mazes of the reef. Taking an elevated position in the ship, up the shrouds, in the top, or on the forecastle, and by the appearance of the bottom, they direct the course of the vessel. Brown or discoloured patches indicate coral and reefs. And it must be insisted on, that only the practised eye of the Bermudian pilots can be depended on for conducting a ship safely. The central portion of the reef forms an imperfect lagoon, with an average depth of 7 to 8 fathoms.

The outer border of the reef is shallower than the centre, many parts having less than a fathom over them, and the others varying from 3 to 4 fathoms. Within this external and rocky barrier, which is about a mile in breadth, the coral and rocks raise their heads in countless numbers, the intervals having a depth of 5 to 10 fathoms. There are some large tracts clear from shoals, as that to the North and West of Murray Anchorage; these have a nearly uniform depth of 7, 8, or 9 fathoms.

Round the West, N.W., and North sides, it is a continued and very dangerous ledge of rocks, beginning at the *Long Bar*, the South part of which lies 6 miles W. by N. from Gibbs' Hill; trending then N.E., it is called the *Chub Heads*, which, off Wreck Hill, lies 9 miles from the shore; the ledge hence rounds to E.N.E., and joins the North Rock, which is always above water, and lies N. ¼ W. 12 miles from Crawl Point. From the North Rock the reef rounds East and E.S.E., and ends in *Mills' Breaker*, which dries at low water, and lies N.E. by E. northerly 14 miles from Gibbs' Hill Lighthouse, and N.E. by N. ½ N. from St. David's Head. On the south-eastern side of the island the reef bordering the group does not extend more than a quarter of a mile off shore. The outer edge is one continued line of breakers, many of which are dry at low water. Within the external and narrow border of rocks, on this face, the water increases considerably in depth nearly to the shore. At the S.W. corner of the reef, and on its outer edge, is a spot that always breaks, called the *South-west Breaker*. It lies 1½ mile off shore, and is nearly South, true, from Wreck Hill, and S.W. from Gibbs' Hill. Round the outer edge of the ledge is a margin of soundings, of from 1 to 2 miles broad, having from 9 to 14 fathoms on it; there are, likewise, soundings for 2 miles from the shore round the N.E., East, and S.E. sides of the island; but, as the water here is deeper, it would be prudent for those who suspect themselves near the longitude of Bermudas in the night, or in thick weather to keep a lead constantly going, being assured that, at 14 fathoms, they will strike the ground in time to avoid danger. The lead might be encased with tallow, for the greater certainty of striking the ground; this precaution would prevent many of the wrecks that constantly happen here.

The Channels through the outer edge of the reef, commencing with the Narrows at St. George's, at the eastern extremity, are as follows:—

The NARROWS is regularly buoyed with *black* buoys on the port side in entering, and chequered *black* and *white* buoys on the starboard side. It may be considered as the principal entrance to the interior of the reef. At each end of the Narrows is a fairway buoy. At the East end, a *black* buoy with staff and globe. Within the reef, at the West end of the Narrows, a *red* conical buoy is placed, which lies in 9½ fathoms water, a mile N.W. of St. Catherine's Point, and should be left well to port by vessels proceeding to sea.

On the South side of the Narrows is the channel over the *Bar* to St. George's Harbour, hereafter described.

Boiler Channel.—There is another channel running East and West to St. George's called the Boiler Channel, passing North of, and close to, Jenkin's Boiler Shoal, with a depth of 12 to 18 ft. It is entered with the old battery below Fort Cunningham, bearing about West. At a cable eastward of the old battery is a *white can buoy*, whence the channel trends more southerly into St. George's Harbour.

Still farther South is an entrance sometimes used by small vessels running under St. David's Head, but it has not more than 9 feet at low water. This leads in a N.W. direction.

Mills' Breaker Channel, the next channel northward, has its entrance half a mile North of the Mills' Breaker. Its direction inwards is S.W. towards the Narrows, and is only used by Bermudian vessels in and out. Mills'

Breaker, in 1875, had a buoy placed near it, N.N.E. $\frac{3}{5}$ E. $2\frac{3}{4}$ miles from St. David's Head.

Continuing in the same direction, the north-eastern face of the reef presents an impenetrable and continuous reef, often breaking, until we come to the *North Rock Channels*, having a southerly direction.

There are two channels on either side of the North Rock. They are known only to a few of the pilots, and from that cause but seldom used, although it is said that the eastern channel is one of the best through the edge of the reef. It is narrow and intricate at its entrance; the general depth is 6, 7, and 8 fathoms, but in one spot only 5. At $5\frac{1}{2}$ miles in the direct line from the entrance, toward Murray Anchorage, there lies a cluster of rocks, which render a circuit to the westward advisable. The mark for clearing the West end of these, the *Three Hill Shoals*, is Painter's Hill, over a hill on the western side of the Ferry at St. George's Island, bearing S.S.E. There is also a channel through the shoals, which is more direct; the mark for which is Painter's Hill, in the hollow or saddle of Two Hills (hence their name), at the West end of St. George's Island, bearing S. $\frac{1}{2}$ E. As soon as the shoals are cleared in either case, which will be when $3\frac{1}{2}$ miles from the shore, you can bear round to the S.E. to Murray Anchorage, this part of the reef being clear.

West *Blue Cut*, on the western side of the reef, can be used only by small vessels. It is exceedingly narrow and intricate, and has only 8 ft. water in places. Its direction is to the East of South.

The *Chub Cut* is the next channel southward; this is also narrow and dangerous. It leads southerly to Wreck Hill, or first southerly and then easterly to Ireland Island.

Hog Fish Cut lies at the south-western angle of the islands. For half a mile in a north-easterly direction it lies through numerous rocky shoals, and then turns to the N.W. It leads to Ireland Island and to Ellis Harbour.

The Hog Fish Cut, which has recently been examined with a view to its improvement, is the most convenient at the West end of the islands, particularly in the winter season, when the winds prevail at N.W., and the danger of being at sea and about the islands is the greatest.

The Hog Fish Cut, though not far from the land, is an entrance from the ocean, through the outer barrier of rocks. Before arriving at the Cut, there are the *Bream Shoals*, to be carefully avoided, and this will be done by keeping the two beacons erected on the West part of Bermuda Island in line, N.E. $\frac{1}{2}$ N., until Gibb's Hill Lighthouse bears E. $\frac{3}{4}$ S., when the channel turns to the N.N.W., following parallel with the shore at a distance of 3 or 4 cables. The course through what are called the Chops of the Cut is nearly at a right angle; the turn is very sudden and sharp, and the greatest nicety must be observed by the pilots in navigating it. The passage is so narrow that it does not afford sufficient space for vessels to tack in, and when a passage through them shall be attempted, it must be without a change of tack. These difficulties are felt more especially in the winter season, when the winds are generally unfavourable for passing the Kitchen Shoals. To remedy this evil, the committee for the purpose (August, 1846) recommended the removal of the centre Kitchen Shoal, of coral (8 ft. on it at high water), by the same means employed at St. George's Harbour, when a passage suffi-

ciently capacious would be opened, and vessels now often compelled to remain at sea, or make the circuit of the islands in search of shelter, would find an easy and ready access to port.

The various channels here mentioned, having different directions, are available according to the wind, that which is fair for one being the reverse for others; but they must not be attempted without a pilot, who will immediately come off from St. David's Head, upon a signal being given to that effect; and a vessel in the offing requiring a pilot, it is telegraphed from one part of the islands to the other by the chain of signals established thereon. They will be best understood by referring to the chart.*

The south-eastern face of the reef forms nearly a continuous line of breakers, about 2 cables' lengths from the shore, and has no entrance or shelter till we come to *Castle Harbour*, hereafter described, the entrance to which, past the King's Castle, is in a N.W. direction. There is no other opening through the reef between this and the channel under St. David's Head, before described.

The South-western Banks.—There is a rocky fishing bank, now named *Challenger Bank*, lying from S.S.W. to S.W. from Gibbs' Hill (or S.W. part of Bermudas), from 4 to 5 leagues distant, and having 22 to 40 fathoms. These banks were surveyed in 1829 by the officers of H.M. sloop *Columbine*, according to whom the northern extremity of the *Inner Bank* lies in 32° 6′ N. and 64° 53′ W.; the S.W. in 32° N. and 65° W. The least water found is 22 fathoms, corally and rocky bottom. On the edges are 40 fathoms. To the S.W. of this bank is another, called the *Outer Bank*, the N.E. end of which is in lat. 31° 59½′, long. 65° 2½′; the S.W. end in 31° 57′, and 65° 5′. The least water found on this bank was from 33 to 47 fathoms, rocks and coral. From this Outer Bank the land is distant 32 miles, and consequently not visible.

The ISLANDS.—Ireland Island is the north-westernmost of the group. Its North point is in lat. 31° 19′ 45″ N., long. 64° 51′ 30″ W. The flagstaff, which is the highest point of the fortification, and stands above the breakwater, is one of the four telegraphic signal stations established on the island. The site of the Royal Dockyard and Naval Establishment is on the North extremity of the island, from the rest of which it is separated by a deep dry ditch.

Ireland Island is about 1 mile in length, and perhaps a quarter of a mile broad, and is nearly all occupied by the buildings required for the officers, artisans, and for storehouses. The hospital is situated on the highest part of the island, and is very large and commdious. The officers' residences are built in the English style, and are very comfortable. The most important work is the breakwater, similar to that at Plymouth. Several hundred convicts are employed on it. The dockyard is kept in fine order.

Between Ireland and Somerset Islands there are several smaller ones, the chief of which is *Boaz's Island*. These are united by a roadway.

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* A Chart of the Bermudas or Somers' Islands, with Plans of the Narrows and Grassy Bay with Ireland Island, published by R. H. Laurie, May 1st, 1878, accompanied by a Description of the Islands, and Sailing Directions.

Somerset Island is the next in order. Its western point is Daniel's Head, off which is a small island.

Ellis or *Elies Harbour* lies between its southern extremity and Wreck Hill. This small harbour may be reached from the Hog Fish Cut, from Ireland Point, or by the Chub Cut. Between Somerset Island and the N.W. side of the reef the ground is all rocky, so that the channels to the harbours are very circuitous, and no directions can be given for them.

GREAT BERMUDA ISLAND.—This, the chief of the group, is about 12 or 13 miles in length. About the centre of it is the town of *Hamilton*, standing on the North side of the harbour, an inlet of the island. It is a free port, and the seat of the legislature. North of the town, which consists principally of one street 1¼ mile long, parallel with the shore in an East and West direction, and about midway between the ferry at the West end of the island and the dockyard, is one of the houses appropriated to the Governor for the time being.

"Hamilton is a quaint, rather pretty little town of about 2,000 inhabitants. A half-street of regular houses and stores with green verandas faces the harbour, with a commodious line of wharves and sheds along the shore. The better houses are scattered and a little inland, and some very pretty villas, the residences of the leading merchants and some of the Government officials, occupy pleasant situations round the head of the bay. The suburbs of Hamilton show well the peculiarity of the contrast between the white-roofed houses and the dark junipers. Nearly the best examples of these so-called 'cedars' form a fine avenue just behind the town."—*Sir Wyville Thomson.*

Hamilton is scarcely seen from the water; but near it is a hill called *Mount Langton*, laid out as pleasure grounds, and on which is a flagstaff, by means of which communication is kept up between St. George, Somerset, and the dockyard. A few miles beyond this is the residence of the admiral, *King's Hill* or *Clarence Lodge*. Between this and Ireland Island is *Grassy Bay*, the anchoring place of men-of-war.

The greatest extent and diversity of land is in Long Island, between Hamilton and the shore of Harrington Sound. The country is undulating and well wooded, with here and there extensive brackish water marshes, cumbered with a luxuriant vegetation. It is intersected by good roads, and dotted with white-roofed houses, churches, and school-houses.

From *Spanish Point* to Ireland Island a ledge of rocks divides the *Great Sound* from Grassy Bay. There are two passages through this—one called the *Stag Channel*, near Sober Island, the North entrance; and one nearer to Spanish Point. Through these is the channel to Hamilton Harbour. There is also another line of reefs running between the North point of Somerset Island and the chain of islets South of Hamilton Harbour. This reef has also to be passed to enter the Great Sound, South of which is *Port Royal Bay*.

The eastern end of Bermuda Island is occupied by the *Little*, or, as it is more commonly called, *Harrington Sound*, a sheet of water only communicating with the sea by a narrow channel, called the Sound's Mouth, over which is a bridge at *Flatts Village*. Through this passage the tide ebbs and

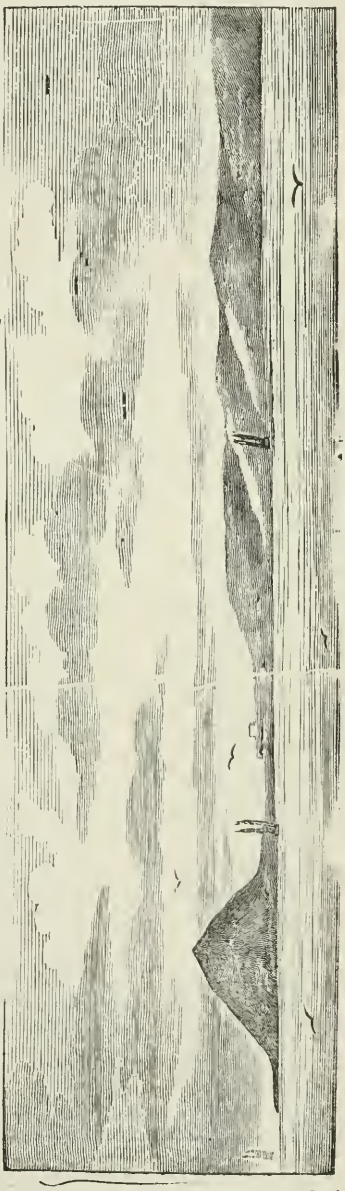
flows with great velocity, but does not pass in sufficient quantity to sensibly affect the level of the water within.

The southern shore of Bermuda is the boldest among the islands, and vessels may come in some places within half a gun-shot of the shore.

East of Mount Langton is Brackish Point, near which is "The Wells," a government establishment for supplying water to the navy, should there be no water at the naval tanks on St. George's Island.

(The following description of the coasts is principally by Lieutenant John Evans, R.N., commencing with the West.)

The westernmost projecting headland is *Wreck Hill*: it stands insulated on its base, is cone-shaped, and very dark-coloured. When seen from the S.W. it appears flattened at its summit, but from the South as peaked. It is the land looked for, and first seen, when approaching the isles from the West.



Wreck Hill, on the western extremity of the Isles, bearing N. ¾ E.

On the western shores of Bermuda the sea is slowly hollowing out the low sandstone cliffs, and on the South the gales of winter cause the sand to encroach on the cultivated land. It is said that much has been lost from the selfish policy of felling the large cedar trees which once formed a barrier around this part of the island.

Gibbs' Hill.—The next particular guide is Gibbs' Hill, which is the highest and most conspicuous eminence observable near the S.W. part of the coast. It is a smooth mount, entirely clear of trees, with the *lighthouse* (previously described) and a telegraphic post on its summit. To the westward, and contiguous to it, is a table-land, crowned with a grove of dark tall cedars.

Between Gibbs' Hill and Castle Island, to the E.N.E., there are several sandy mounts, having the appearance of white cliffs, and at moonlight may be mistaken for breakers. These are very remarkable, and are called the *Sand Hills*. One of these is much more conspicuous than the others, being of greater extent, and without any verdure upon the summit. At 2 miles

East of the great sand hill is Castle Harbour, in the entrance to which are several islets and rocks; on the largest of these is an old castle, which gives name to the harbour. These islets are remarkable for the colour of the cliffs and the dark verdure of the turf which covers them.

The coast here presents a very picturesque appearance of land and water; Telegraphic Hill over St. George's is a pleasing object in the perspective. This may be termed the S.E. face of the islands, and is considered as the best parallel to make them in from the eastward.

In the winter, with the wind from the N.E., there is a strong set of the water to the S.W. on the South side, and it is very tedious and unpleasant to turn to windward, the wind blowing in heavy squalls at intervals. I have, however, known South and S.W. winds to prevail during most part of the winter months.

Castle Harbour.—In Castle Harbour there is good anchorage, but it is not used by men-of-war. A frigate, many years ago, was wrecked in her endeavour to get out. The southern channel to the harbour is narrow and intricate: the mark to lead across the outer edge of the reef is *Minor's Hill*, on the North side of St. George's Island, midway between Castle Island and Southampton Island. As soon as this is crossed, bear to the eastward, and steer close to the eastern side of Castle Island, which is steep-to, and then pass between the banks which border the channel for about one-third of a mile North of Castle Island; then bear round to the eastward, and anchor in 5½ fathoms, one-quarter of a mile North of *Nonsuch Island*.

In working from the S.W. end of Castle Harbour, ships may stand within a mile of the shore; and small craft until the bottom is seen. There are some small reefs and ledges along the line of shore, but they are very near the beach.

St. David's Head, near which a *lighthouse* is constructing on Mount Hill,* is next seen, in the form of a round bluff, covered with foliage, and, when the land is opened to the northward, a large cave will appear to view beneath the head. A reef extends from this bluff, about half a mile off shore; the sea generally breaks over it.

Vessels waiting for pilots may run in to the N.E. of the bluff, and heave-to with their head off shore; the bottom is hereabouts visible, but no danger may be apprehended on that account.

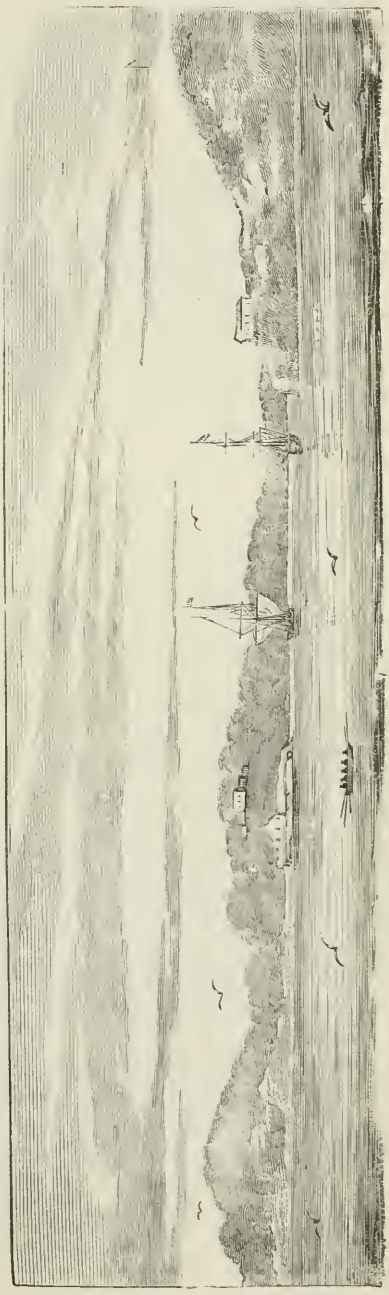
The pilots are the most expert I ever met with. A good look-out is kept by the artillerymen stationed at the Telegraph Hill, and delay seldom takes place.

Beyond St. David's Head the land trends to the N.W. *St. George's Harbour* (the best among the islands) is formed by several islands, and a curve in the larger island of the same name; its entrance lies between Port Paget and a small kay to the eastward. The harbour is landlocked, well sheltered from the stormy West and N.W. winds, with a good depth of water over a

* There is in this neighbourhood a zone of fully 5 miles in width (measured at a safe distance outside the reefs), within which the light on Gibb's Hill is intercepted by high land. It is needless to say how greatly the security of vessels making the East end of the island at night or in thick weather will be promoted by a lighthouse in this quarter.

bottom of stiff pipe-clay. The vicinity to the open sea alone gives it a decided superiority to the anchorage of Grassy Bay, if there were nothing else to recommend it.

ST. GEORGE'S ISLAND is "the military station of the colony, and formerly the seat of government; is about 3 miles long, and at no part exceeding half a mile broad; it lies at the entrance of the only channel for ships of burthen. The Harbour of St. George, when once entered, is said to be one of the finest in the world, and capable of containing the whole British navy. It is completely landlocked. The entrance to the harbour is narrow, and is protected by Cunningham Fort. After passing this entrance, the town presents one of the most beautiful landscapes the eye ever rested upon."



The Entrance of St. George's Harbour, bearing West

"The town of St. George's is the second on the islands, even more prettily situated than Hamilton, and having likewise a good harbour for vessels of moderate size, and a good line of wharves. The streets of the town are, however, close and narrow, and the drainage is bad; so that St. George's, one of the principal military stations, is by no means healthy. St. David's Island, Cooper Island, and many smaller islets, form a broken barrier, closing in Castle Harbour to the southward."—*Sir Wyville Thomson.*

The roadstead, from whence ships proceed to St. George's Harbour, is called the *Five Fathom* or *Outer Hole*; within this is the *Inner Hole.* Two buoys lie on the North side of Five Fathom Hole, about a mile N. by W. from St. David's Head. They are the first buoys marking the eastern entrance to the Narrows, and lie East and West of each other, a cable apart. Having passed between them, proceed to the N.W., leaving chequered buoys to starboard, and black buoys to port.

The Five Fathom or Outer Hole, where ships wait with winds not fair for going to Murray Anchorage, has from 5 to 10 fathoms. The mark for anchoring is the Cherrystone or Sugarloaf Hill (at the head of Mullet Bay) open of the old battery on the point of St. George's Island, bearing West by compass; St. Catherine's Point about W.N.W., and the rocks off Cooper's Island open to St. Davids's Head, S. ½ W.; but in letting go your anchor, look out for a clear spot.

The passage over the bar to St. George's Harbour is marked by two white buoys on its western side, and two black buoys on its eastern side. The bar marks are "a stone pillar and a white stake in a line, bearing about S. 20¼° W. by compass;" they lie on the slope on the North side of St. David's Island. Carry on this course until Smith's Fort on Governor's Island, which forms the South side of the entrance, bears S.W. by W. ½ W., and then steer for it, and when nearly up to it, bear round between it and the point, when the town will open on the starboard bow; whence you may proceed to the anchorage, keeping the N.W. shore on board. The passage over the bar is between two poles on the North side, and two on the South side. Four other poles mark the channel S.W. of this.

The depth on the bar is 16 to 18 ft.; within it, and in the channel, 4 and 5 fathoms. Several rocks have been removed which formerly existed in the entrance of the harbour.

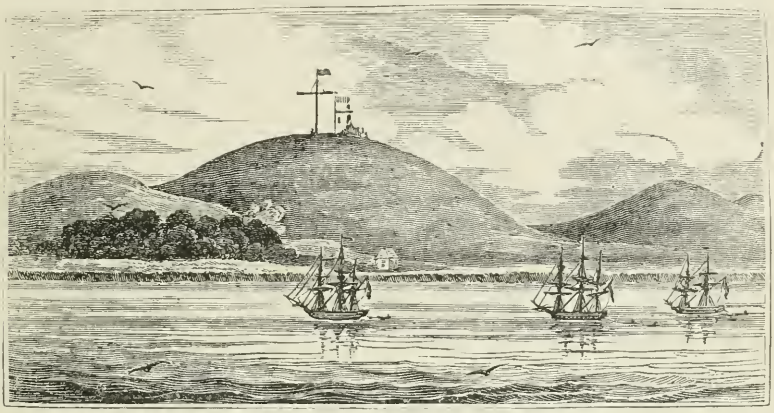
The *Marine Slip* at St. George's is used by an average of about fifteen vessels every year; the largest vessel it has taken up was one of 904 tons in 1873. The capacity of the slip is for vessels of 1,200 tons.

High water, full and change, at St. George's, 8¼h. Common tides rise to about 4 ft., but springs, or in gales of wind, they frequently rise 6 or 7 ft. The floods in the offing set to the N.E., and ebb to the S.W., but near the shore they run in various directions.

"*St. Catherine's Bluff* is the north-eastern extremity of St. George's Island and of the isles in general. There is a fort upon it and a battery. Beyond this head, to the westward, is *Murray Anchorage*, one of the most unpleasant places in the world to ride in during the winter season. I have been for several weeks riding out a N.W. gale in a frigate here, pitching bows under; and the *Driver*, a sloop-of-war, is said to have carried away her bowsprit, in consequence of its getting under the cable, when she was in the act of plunging during a gale. The *North Rock*, at about 8 miles in the offing, appears from this anchorage through a telescope like a ship's boat with three lug sails. There is a passage of egress for large ships through the reefs near the rock, but it cannot be attempted without a fixed leading wind; boats are then placed on either side of the channel to guide the pilot."—*Lieutenant Evans*

Murray Anchorage "lies on the S.W. side of Catherine Point, extending from Tobacco Bay to the Ferry, between St. George's and the Great Bermuda; whence, after going through a passage to the westward, there is secure anchorage from abreast Brackish Pond, across the entry of the Great Sound, to Ireland Island. The common entry into Murray anchorage is through an intricate and narrow passage round Catherine Point, called the *Narrows;* for the particulars of which see the Chart, as no description can be given here that will be of any use to a stranger. The ground in the

entry, as well as over the anchorage, consists of stone, of the soft, dripstone kind, ground as fine as flour, mixed with a shelly substance and a chalky clay; it is very heavy, therefore the anchors do not sink deep in it, and they loosen immediately when a-peak; but it is rarely that ships drive in it.



St. George's Island and Signal Station, from Murray Anchorage.

Ships bound for Murray Anchorage will generally get a pilot off Castle Harbour, or they may run as far as St. David's Head. When to the eastward of St. David's Head stand no farther to the northward than to bring the Head N.W.; you will see a white sandy bay to the southward of the Head, between it and Castle Harbour. In standing to the northward, care must be taken to shut no part of this bay in behind St. David's Head. The West land of Bermudas will be shut in behind the land, over this bay, before this mark comes on.—*Mr. Murdo Downie.*

A patch of coral rock on which H.M.S. *Ariadne* touched in 1872 lies between the Fairway and inner chequered buoy of the channel of the Narrows. It had 22 feet water on it, but this has been deepened by blasting to 24 feet at low water. From the shoal the Fairway buoy bears N.W. $\frac{1}{2}$ W., 4 cables; inner chequered buoy, E. by S. $\frac{1}{2}$ S., $3\frac{1}{2}$ cables; and the West extreme of Catherine Point, S.S.E. $\frac{1}{4}$ E., 7 cables.

The naval tanks lie abreast of Murray Anchorage, just above *Tobacco Bay*, wherein is the landing-place. There is not a spring in the isles, but ducks are abundant.

From the anchorage of Grassy Bay sailing ships, unless they happen to be favoured with a leading wind, are generally one day working up to Murray Anchorage, a distance of 9 miles; and there they must wait until the wind proves fair before they can get to sea round St. Catherine's Bluff, and through the intricate channel which leads to St. David's Head. Even with a fair wind to or from Ireland Island (on which the dockyard is situated) ships are liable to strike upon the heads of the rocks everywhere scattered about.—*Lieut. Evans.*

Directions for making the Bermudas, by Mr. Murdo Downie.

Vessels, in hazy weather or in the night, must be very cautious in ap-

proaching, lest the winds or currents should set them on the reefs, or into some inextricable channel. Be particularly cautious in coming from the S.W., as upon the rocks off this end of the island, from S.W. to W.N.W., many ships have been lost. No stranger should attempt any of the anchorages without a pilot, many of whom are always on the look-out, and put to sea when a vessel heaves in sight. Their boats may be readily known, being of a peculiar construction and rig; of a light draught of water forward, with a long heel or deep sternpost; rigged with one mast and bowsprit, carrying a triangular mainsail, a foresail, and jib, and, occasionally, a gaff topsail and squaresail.

The prevailing winds with fine weather in these seas being from between the South and West, vessels from the West Indies and America generally make these islands by running on their latitude from the westward. The best latitude for that purpose is 32° 8′, always having regard to a small probable current in the direction the wind blows; steering East, you will first see the land a little on the port bow, being two small sand-hills, close together, having a white house on the top one, and cedar wood on the other (these are called Gibbs' Hills, distinguished by the lighthouse before mentioned); as you near the land, you will see Wreck Hill farther to the northward, appearing peaked, and joined by low land to that first seen; steer to bring Gibbs' Hill to bear E.N.E., and, when within 6 miles of the land, take care it is not to the eastward of that bearing, because of the rocks called the Long Bar. Then steer so as to pass within 2 miles of the S.E. land; and, when Wreck Hill shuts in behind the South land, you are clear of the S.W. breaker, and may steer along the S.E. side of the island, at a mile distant from the shore, until abreast of St. David's Head, there being nothing to hurt a ship but what is in sight.

In running for Bermudas from the eastward, the best parallel is between latitudes 32° 10′ and 32° 20′; in which a ship may run boldly, as there are no rocks at any distance from the land.

When running down a parallel for Bermudas, with a large wind, and not making the land toward night, but expecting to be near it, no vessel in this situation, ought to lie-to, but should rather turn to windward, under an easy sail, until daylight, because of a probable current, as before mentioned, which has deceived many by bringing them unexpectedly among the rocks. The land not being high (Gibbs' Hill, on which is the lighthouse, is the highest land in the islands), it cannot be seen at any great distance from a small vessel; added to this, the thick haze that frequently prevails here, particularly in fine weather, renders making the land somewhat difficult, and at times precarious, unless the latitude be accurately ascertained; for instances have happened of vessels missing the islands, and after a fruitless search steering for the American coast in order to take a fresh departure for running down the latitude again.

Instructions for Sailing to Bermudas Islands, by Admiral Murray.

Within the Gulf Stream steer well to the southward, perhaps as much as S.S.E., until you get within 3 or 4 miles of the latitude of Cape Hatteras; and then steer S.E. by E. until you get into the latitude of 32° 5′. Thus

you will avoid crossing the Gulf Stream where it is very broad, and its direction far to the eastward, passing it where it affects your latitude more than your longitude; and, of course, be of less consequence to the ship's reckoning; by steering thence so far to the southward as S.E. by E., you will fall into the latitude of the Bermudas at 4 or 5 degrees of longitude to the westward.

You should by no means run for these islands unless sure of your latitude; and always make them from the S.W. if possible, looking out in time for the land, as, owing to the set of the Gulf Stream, and the general tendency of the currents to the eastward, ships from the coast of America will almost always be far ahead of their reckoning.

Having ascertained your latitude, and being well to the westward, get into the parallel of 32° 5′, and steer due East; this course will bring you to the islands, passing about 4 miles clear of the South end of *Chub Heads*, a very dangerous shoal, lying across the West end, about 8 miles from the land, with not more than 12 feet on it at low water; as well as the S.W. breakers, which lie about 1½ mile S.S.W. from the southernmost land, being the shoalest part of a ledge of rocks of considerable length, lying parallel with the shore. Should the wind in the night incline to the northward, keep in 32° 7′ N.; but if to the southward, in 32° 2′.

The soundings do not extend more than 1½ mile from the shore on the South side; therefore you have only a strict look-out to depend on for safety; and as for the East, West, and North sides, the breakers lie from 3 to 4 and 5 leagues off. You must avoid by all means running in the night, without having a good observation the preceding day, and being pretty sure of your longitude. Follow these directions, and you will first make Wreck Hill (which is high land on the western extreme of the islands), the land trending from it to the S.E. Having passed the S.W. breakers, the land lies about E.N.E. and W.S.W., having danger no more than half a mile off, and that generally visible; you may run safely along shore at a mile, until you pass Castle Harbour, which is easily known by the castle on an island on the starboard hand. You should bring-to off the eastern point of this harbour, and wait for a pilot, who will soon come off, and carry you into St. George's Harbour. But should you be pressed for time, or the pilot not come off, you may haul round by the breakers, after having passed the islands which form the South part of Castle Harbour, into St. George's Road, bringing on the following marks:—

A high island next to the N.E. part of the small ones off Castle Harbour, has at its eastern extremity a bluff rocky point, called St. David's Head, having breakers off it about half a mile; the northernmost land in sight, after you haul round St. David's Head, is called St. Catherine's Point; bring this point to bear W.N.W., and St. David's Head S. ½ W., and you will be in as good a berth as any in the road, with 7 or 8 fathoms of water; but in every part of these roads you must be guided by the eye where to drop your anchor clear of foul ground, which is everywhere easily seen, owing to the clearness of the water and whiteness of the sand where the anchorage is safe.

In case you have been driven to the eastward of the islands (a situation however, which you are to avoid with the utmost care), you may run for

them in lat. 32° 14′ N., which will bring you to them 5 or 6 miles to the southward of St. David's Head, for which you may haul up upon making the land; but you are not to run till you are far enough to the S.W. to follow the directions before given for coming from the westward, should you make sail for Bermudas from any part of the Gulf Stream or without it.

I recommend you to make great allowance for your being to the eastward of your reckoning, and try to fall into the parallel of latitude above mentioned, in longitude 70° or 71° W.

High water at St. George's, full and change, $8\frac{1}{4}^h$. Spring tides rise about 6 ft.; common, 4 ft. The tides are various, both in height and time, at different parts of the islands. The Bermudas bear from Cape Henry S. 63° 35′ E., distant 210 leagues.

Remarks on the Bermudas, and Passages to and from, by Commander Dunsterville, R.N., 1830-31.

In July, 1830, from the Maternillo Bank, on the N.W. of the Bahamas, to the Bermudas, the winds prevailed from the S.E. to S.W. Light breezes and cloudy, with heavy rains at times. Found no current.

The Bermudas from the S.W., at 5 leagues distant, appear as an assemblage of detached high islets, on the South part of which the signal-post on Gibbs' Hill is seen, being erected on the highest land in the islands. Hence we ran along shore, at $1\frac{1}{2}$ to 2 miles off.

During our stay at these islands the winds prevailed for seven weeks from S.S.E. to S.W., which is invariably the case here during the summer months. Rise of spring tides about 3 ft. 6 inches. High water at 6^h.

When a signal for a pilot is made from ships in the offing, it is telegraphed by the signal-posts throughout the island.

To lay through the Narrows, near St. George's, it is requisite to steer from N.W. to W.N.W., and from St. Catherine's Point (the N.W. point of St. George) S.W. by S. and S.W., till Ireland Island bears about W. by N., whence haul to that course. In every course avoid all brown or dark patches, which are corally rocks, with little water on them. In the channel are from 6 to 7 fathoms. The buoys invariably point out all the rocky heads, which in some parts are numerous. In the latter end of September fine North and N.E. winds; the thermometer at 74°, which had been for the last two months from 80° to 84°. The *Ranger* anchored at Murray Anchorage in 10 fathoms, chalky bottom. St. Catherine's Point, E. $\frac{1}{2}$ N. about mile.

The *Ranger* sailed for Bermudas from Jamaica on the 5th of October. Winds prevailing from the N.N.E. Fresh breezes and fine weather.

Winds light from the eastward until we arrived at Bermuda, when it blew strongly from the southward and westward for a fortnight. On the 11th of April anchored off Irelaud Island. Vertical rise of spring tides here about 5 ft.; neaps, 2 or 3 ft. High water at 8^h.

Going through the Narrows at Bermuda.—The channel is marked out by *chequered* buoys, and at each end a fairway buoy is placed; the westward or inner one being *red*, and the outer one *black* with staff and ball. The *red*

buoy lies in 9½ fathoms about a mile N.W. ½ W. of St. Catherine's Point. Vessels should keep well to the southward of it in entering. The courses through are from W.N.W. to N.N.W. ½ W. The best anchorage at Murray Anchorage is in 9½ fathoms, off St. Catherine's Point, with the East signal-staff in St. George's S. by E. ½ E., off shore one-quarter of a mile. Between St. Catherine's Point and Mount Langton (the governor's house) keep the shore well on board; say one-quarter of a mile or less. In clear weather the dangers show themselves.

With the remarks on the islands by Mr. Dunsterville, the following, since made, may be included:—

"The land generally of these islands is low; yet there are many parts, as *Gibbs' Hill*, *Mount Langton*, the North part of *St. George's* and *St. David's*, that may be seen in clear weather 5 leagues off. The isles, as shown hereafter, are surrounded by most dangerous reefs, the S.E. side excepted, which may be approached within a mile, until abreast of the N.E. point, called *St. David's Head*. Off this head pilots are readily obtained by displaying the usual signal. The government pilots may be known by a narrow blue burgee, with a broad arrow in white therein.

There is anchorage without the Narrows on a spot called *Five-fathom Hole*, with St. Catherine's Point about W.N.W., and St. David's Head S. ½ W.; but in letting go the anchor look out for a clear spot.

In proceeding for the Narrows the first buoy seen, which is black, is the leading buoy for the fairway. In the Narrows are 6 and 7 fathoms of water.

If you intend anchoring in Murray Anchorage, bring St. Catherine's Point to bear East; the signal-staff at St. George's, S. by E. ½ E., in 9½ fathoms, chalk bottom, at a quarter of a mile off shore. From this anchorage to Ireland Island, where the men-of-war lie, is about S.W. by S. to abreast of Mount Langton, the governor's country residence, keeping the shore about one-quarter of a mile distant. When Ireland bears about W. by N., you then haul for the island, passing between two corally spots, nearly abreast the Admiral's house. In clear weather all the reefs are readily discerned, and may be avoided with a common degree of care. From Murray Anchorage to Ireland you have in the channel 7 and 6 fathoms.

During the summer months, from April to September, the winds prevail from S.S.E. to S.W. Thermometer, 80° to 84°. About the latter end of September the northerly winds set in, when the thermometer falls to 70° and 74°; quite a bracer for the constitution. The rise of tides at springs is about 5 ft., neaps 2 or 3 ft. High water at Ireland Island, full and change, at 8 o'clock. The tide at the Narrows sets from 1 to 2 miles in the hour.

The height of Gibbs' Hill signal-station is about 200 ft.; of Wreck Hill about 150 ft. On the S.E. side is a large space of sand, called *Sand Hills*, which is very remarkable. The North Rock is about 16 ft. high, 20 ft. long, and 6 ft. wide; here the currents are strong and very variable, but mostly to the eastward in the offing.

A branch pilot has 3s. per day, with allowance of provision, and 1 dollar per foot for any government ship.

Directions for Sailing near the Bermudas, on coming from the Westward.

"On coming from the westward, the S.W. points of the land ought to bear E.N.E. before you come within 4 leagues of the land, when you may steer directly for it without danger. The breakers on the South side always show themselves; so that a ship may safely approach within gun-shot from the S.W. end to the S.E., and when getting to the eastward of the castle, round into St. George's. Do not go farther to the northward than to keep Cooper's Island open within St. David's Head till you take a pilot; and the subscriber engages no ship will ever strike if this be attended to."—*Thomas Lean*, 1808.

On the Winds and Navigation of the Bermudas, by His Excellency the late Colonel (Sir W.) Reid, Governor of Bermuda.

The first half of a revolving gale is a fair wind from Bermuda to New York, because in it the wind blows from the *East;* but the last half is a fair wind from New York to Bermuda.

During the winter season most of the gales which pass along the coast of North America are revolving gales. Vessels from Bermuda bound to New York should put to sea when the N.W. wind, which is the conclusion of a passing gale, is becoming moderate, and the barometer is rising to its usual level. The probability is, more particularly in the winter season, that after a short calm the next succeeding wind will be easterly, the first part of a fresh revolving wind coming up from the S.W. quarter.

A ship at Bermuda, bound to New York or the Chesapeake, might sail whilst the wind is still *West* and blowing hard, providing the barometer indicates that this West wind is owing to a revolving gale, which will veer to the *northward*. But as the usual track which gales follow in this hemisphere is northerly or north-easterly, such a ship should be steered to the southward. As the wind at *West* veers towards *N.W.* and *N.* the vessel would come up, and at last make a course to the westward, ready to take advantage of the *East* wind at the setting in of the next revolving gale.

A vessel at New York, and bound to Bermuda at the time when a revolving wind is passing along the North American coast, should not wait in port for the westerly wind, but sail as soon as the first portion of the gale has passed by, and the N.E. wind is veering towards the *North;* provided it should not blow too hard. For the *North* wind will veer to the *westward*, and become every hour fairer for the voyage to Bermuda.

A great number of gales pass along the coasts of North America, following nearly similar tracks, and in the winter season make the voyage between Bermuda and Halifax very boisterous. These gales, by revolving as extended whirlwinds, give a *northerly* wind along the shore of the American continent, and a *southerly* wind on the whirlwind's opposite side far out in the Atlantic. In sailing from Halifax to Bermuda it is desirable for this reason to keep to the westward, as affording a better chance of having a wind blowing at *North*, instead of one at *South;* as well as because the current of the Gulf Stream sets to the eastward.

When vessels from Barbados, or its neighbouring West India Islands, sail to Bermuda on a direct course, they sometimes fall to the eastward of it, and find it very difficult to make Bermuda when westerly winds prevail.

They should therefore take advantage of the trade wind to make the 68° or 70° of West longitude, before they leave the 25° latitude.

On a ship leaving England for Bermuda, instead of steering a direct course for the destined port, or following the usual practice of seeking for the trade winds, it may be found a better course, on the setting of an *easterly* wind, to steer West, and if this wind should veer by the *South* towards the West, to continue on the port-tack until, by changing, the ship could lie in its course. If the wind should continue to veer to *North*, and as it does sometimes even to the *eastward of North*, a ship upon the starboard tack might be allowed to come up with her head to the westward of her direct course. On both tacks she would have sailed on *curved lines*, the object of which would be to carry her to the westward against the prevailing wind and currents. There is reason for believing that many of the revolving winds of the winter season originate within the tropics; and that ships seeking for the steady trade winds, even farther South than the tropic, at that period of the year, will frequently be disappointed. How near to the equator the revolving winds originate in the winter season, is an important point not yet sufficiently observed. The quickest voyage from England to Bermuda, therefore, may perhaps be made by sailing on a course composed of many curved lines, which cannot be previously laid down, but which must be determined by the winds met with on the voyage. This principle of taking advantage of changes of revolving winds, by sailing on curved lines, is applicable to high latitudes on both hemispheres, when ships are sailing westerly.—*Government House, Bermuda, 21st March*, 1846.

9.—ROCKALL, OR ROKOL.

This is a large and high rock, of a conical or sugarloaf shape, the summit or upper part of which is perfectly white, from an immense quantity of birds' dung, with which it is covered. The rock had been seen many times, but its true situation was unknown till the year 1810, when it was ascertained by Mr. T. Harvey, master of the *Endymion* frigate. In Captain Vidal's survey of the western banks it is represented in 57° 36′ N., and 13° 41′ W. There appear to be dangers both to the N.E. and to the S.W. of the rock.

Rokol, 2 miles distant, as taken by Mr. Harvey.

It was more particularly examined in August, 1862, in H.M.S. *Porcupine*, commanded by R. Hoskyn, Esq., R.N., when surveying the bank of deep soundings West of Ireland, and during which survey the *Porcupine Bank* was discovered. The following is Mr. Hoskyn's account of it:—

Rockall is in lat. 57° 35′ 52″ N. by meridian altitude of sun; long. 13° 42 21″ W., mean of a.m. and p.m. sights, four chronometers, sea horizon. The

rock has an elevation of 70 ft. above the sea, is about 250 ft. in circumference at its base, and is composed of a coarse granite.

The summit of the rock, sharp-pointed and whitened by birds, can only be gained from its N.E. side, and landing is at all times difficult, for it is steep on all sides. On the N.E. side, however, is a small detached rock, called Haslewood Rock, uncovered at half-tide, with 30 fathoms of water between it and Rockall, from which it bears N.E. by N. a cable and a half distant.

N.E. Dangers.—With the rock bearing N. by W., broken water appeared to the N.E. of it; and on approaching nearer, a rock, on which the water broke, appeared just at the water's edge. When due South of Rokol, the breakers were in a line with the eastern part of it. The sunken rock bears N. 73° E., from it, at least $1\frac{3}{4}$ mile distant. This rock may be named the *Helen Rock*, as it is probably that on which the vessel was wrecked as recorded below, unless there exists another rock farther off in the same direction.

On the N.E. rock just mentioned, until then unknown, and lying about 2 leagues, or less, E.N.E. $\frac{1}{2}$ E. (by compass) from Rokol, the brigantine *Helen*, Captain Erskine, of and from Dundee, struck fatally, on the 19th of April, 1824.

It appears from Captain Erskine's narrative, that he estimated Rokol to lie in 13° 40′ W. That the vessel struck twice on a clump of rocks, apparently not much bigger than a ship's length, and on which the sea broke occasionally. No other breakers were in sight at the time. Rokol at this time bore, by compass, W.S.W. $\frac{1}{2}$ W., he thinks about 6 miles distant; but, as the weather was hazy, probably something less.

Captain Hoskyn, R.N., says:—Helen Reef, bearing S. 79° E. 2 miles from Rockall, has about 6 feet water over it at low water. It is very dangerous, and the situation of it is generally shown by its breakers, but towards high water, and in very fine weather it only breaks at long intervals. From being small and steep-to, there is then nothing to indicate the approach to it. To avoid it keep Rockall clear of a W. by N. bearing. There is a safe passage between it and the rock.

The lowest estimate that was formed of the range of the tide (judging from the appearance of the rock) was 6 ft.; but this seems large for a tide-wave in mid-ocean.

The *Rokol Bank* was surveyed by Captain Vidal, R.N. The edge of the bank of soundings, comprehending less depth than 100 fathoms, is 20 miles to the northward, and 35 miles to the southward of the rock; and the least depth expressed, which is on the S.W. of the rock, is 54 fathoms. The whole extent of soundings from N.E. to S.W., within the depth of 200 fathoms, is 55 leagues.

The greatest breadth, which is on the parallel of 57° 30′, is 18 leagues. The North end of the bank, with 163 fathoms of water, is in lat. 58° 19′, long. 13° 40′; and the S.W. end, with 180 fathoms, is in lat. 56° 3′, long. 15° 59′.

10.—SABLE ISLAND, OFF NOVA SCOTIA.

In a former page, 430, there are some remarks on this singular and dangerous island, lying in the strength of the Gulf Stream, and apparently formed by conflicting currents. The *lighthouses* on its eastern and western ends are described in the Table of Lighthouses. Each of the towers answers the purpose of a lighthouse, a house of refuge, a day beacon, a signal station, and a lookout house. Every means, including lifeboats, rockets, &c., are in readiness for rendering assistance to vessels which are in distress. The Humane Establishment and the lighthouses are maintained by the Canadian and British Governments.

The island is formed of two nearly parallel ridges of sand, shaped like a bow, concave to the northward, and meeting in a point at either end. Its whole length, following the curve, and including the dry parts of the bars, is 22 miles; or E. $\frac{3}{4}$ S. 20$\frac{1}{2}$ miles, in a direct line across the curve; its greatest breadth is exactly 1 mile. In some parts it is wholly or partially covered with grass; in others, scooped out by the winds into crater-shaped hollows, or thrown up into sand-hills, not exceeding the height of 75 ft. above high water. Between these ridges a large pond, named Saltwater lake, said to be gradually filling with blown sand, but still in some parts 12 ft. deep, extends from the West end to the distance of 11 miles; and a low valley continues from it 6$\frac{1}{2}$ miles more to the N.E. of the island. The entrances to this pond have been for some time closed, the sea flowing in over the low sandy beach on the South side, and at the West end only in high tides and heavy gales.

Fresh water is to be had almost everywhere, by digging down a few feet into the sand.

Sable Island and its submerged bars form a crescent concave towards the North, and extend over more than 50 miles of sea. Vessels should be careful not to be caught within this crescent in a strong gale from the northward, when the accelerated ebb-tide, setting directly towards and over the bars, would render her situation extremely dangerous. Both these bars are extremely steep on the North side, the East bar especially so, having 30 fathoms water close to it. To the southward, on the contrary, the water deepens gradually out for so many miles as to render it difficult to account for the greater number of shipwrecks having occurred on that side of the island and its bars, excepting by a neglect of the lead.

In approaching the anchorage off Sable Island from the northward at night, or in thick weather, the lead should be kept constantly going, and after passing the Middle Ground, distant about 25 miles to the northward of the island, great caution should be used, and the vessel should be certain of her position; for the East end of the island and the East bar are very steep on that side.

Vessels seldom anchor off the South side of the island, because of the prevailing heavy swell from the southward; but they may safely approach by the lead on that side, taking care not to become becalmed in the heavy swell, and in the strong and uncertain tides and currents near the bars.

The landing is in general practicable on the South side, excepting after a

long continuance of northerly winds; and on the North side boats can land only in southerly winds and fine weather; but there are surf boats at the establishment, which can land when ordinary boats would swamp instantly.

The positions of the various points are given in the Table on p. 57.

11.—PENEDO DE ST. PEDRO, OR ST. PAUL'S ISLETS.

A cluster of five steep, craggy rocks, without verdure, covered with birds' dung, and having no place for anchoring, or convenience for landing. They are about a quarter of a mile in extent each way, and the highest part is about 100 feet above the sea. With a line of 100 fathoms, no bottom was found within 2 miles of the islets. The appearance annexed has been communicated by the intelligent master of a merchant ship.

The rocks change materially in their appearance, according to their bearing. The *Tellicherry*, East Indiaman, passed in sight in 1802, and found that the appearance, between N. 30° W. and N. 37° W., 6 or 7 miles distant, was that of a heap of rugged rocks, with low gaps between some of them. The northernmost, a small pyramidal rock, rather lower than the rest.

Penedo de St. Pedro, West, as taken by Captain Monteath.

Commodore Brou, of the French frigate *Hermione* in 1825, describes Peñedo de San Pedro as a mile in extent, in a N.E. and S.W. direction; seen in fine weather 4 or 5 leagues off; when bearing N.W. appearing in the form of three pinnacles of sharp naked rocks of a remarkable shape. The S.W. pinnacle separated a short distance from the others. The latter appears safe to approach, and no breakers were seen, to indicate sunken rocks. The *Hermione* sailed round on the eastern side at the distance of 5 miles; did not try for soundings, but from the colour of the water it was presumed that bottom would not be found.

The Equatorial Current set the ship to the westward at the mean rate of 18 miles, and to the North 6 miles, in the twenty-four hours between the parallel of 8° N. and the equator, and the meridians of 28° and 30° W. At the islets the direction of the current changed, and set more to the northward, at three-quarters of a mile in the hour.

The best description of this isle is that of Captain Amasa Delano, who, in the American ship *Perseverance*, from Boston toward Cape Horn, 23rd December, 1799, at two p.m. saw three small islands bearing W. by S., 2 or 3

leagues distant. The vessel bore away, and at three p.m. was abreast of them. Hoisted the small boat out, went on shore, and found them to be nothing more than a cluster of craggy rocks, about one-fourth of a mile in extent from North to South, and nearly as much from East to West. No sort of vegetation existed upon them. The rocks were found to be five in number, but only two of any considerable magnitude. Their extent was from N.N.E. to S.S.W. The two largest nearly connect with each other, and form a kind of harbour, or place of shelter for a boat, on the N.W. side. Here they managed to land, but obtained nothing except a number of boobies. On shore the aspect was most dreary, the sea roaring and surging on all sides. Two smaller rocks were lying off to the S.S.W. of the large ones, and one very small to the N.E. When on the highest part, which was at least 100 ft. above the surface of the sea, no daugers could be seen but what showed themselves above water, nor could any be discovered from the ship. Plenty of fish were caught in the harbour or basin. At six p.m. returned on board. Sharks were numerous about the ship, but in attempting to take them a number of hooks and lines were lost, and several pairs of graines broken. On sounding within 2 miles of the islet, no ground could be found with a line of 200 fathoms.

Captain Delano states that the islets may be seen at the distance of 4 leagues, and always make like three sail when first seen. They are very dangerous if fallen in with by night. The current near them sets N.W. by N., true, 1 mile an hour. The parts above the reach of the surf are covered with birds' dung. The birds were hatching their young at the time. The month of November would be the season for procuring eggs at this place, as they may be obtained at that time in abundance; but being the eggs of oceanic birds, they are rather fishy than sweet. We have seen a different latitude assigned to the rocks, but consider it is incorrect.

Admiral FitzRoy, from his observations, places the summit of the Peñedo in lat. 0° 55′ 30″, long. 29° 22′. The rocks were seen on the horizon at sunset of the 15th. They appeared extremely small at about 8 miles distant. At daylight next morning two boats were sent to land upon and examine them, while the *Beagle* sailed round, sounding and taking angles. Good observations were made during the day, as the sky was clear and the water smooth.

"From the highest point of the rocks, which is 64 ft. above the sea, no discoloured water, nor any breaking of the sea could be discerned, apart from the place itself; and from the soundings taken in the boats, as well as on board the ship, I conclude that it is unconnected with any shoal, being merely the summit of a steep-sided mountain rising from the bottom of the ocean. A slight current was setting to the westward, not amounting to a mile an hour."—(FitzRoy, vol. ii. p. 56.)

They were also visited by Sir James Ross, with the *Erebus* and *Terror*, in his Antarctic expedition, on November 28th, 1839. He has given a small chart of them, and the following:—

"We found the steep north-eastern side of the cove the most practicable point for landing, and near it obtained our observations. The remarkable rocks, which lie in lat. 0° 56′ N., long. 29° 20′ W., and more than 500 miles distant from any continent, appear to have been raised by volcanic agency,

and not in any part exceeding 70 ft. above the surface, present the form of an oblong crater, the larger axis lying in a N.E. and S.W. direction."

Dr. M'Cormick, the talented surgeon and naturalist to the expedition, gives also the following remarks:—

"They consist of a group of rocks, scarcely extending half a mile in circumference. The four largest form a kind of bay on the N.W. side, in which there is a considerable swell. The highest rock is on the N.E. side of the bay, rather sharply peaked, 70 ft. above the sea. The next in height, and the most remarkable, from its uniform white colour, is 61 ft., and is on the S.W. or opposite side. This rock is a very hard kind of hornstone, covered with a thin layer of calcareous matter, evidently formed by the excrement of birds. Variation, Nov. 28th, 1839, 13° 20′ W.; in 1872, 15° 50′ West; dip, 27° 8′ N.

12.—THE ROCAS, ETC.

Although this dangerous spot is not strictly within the North Atlantic Ocean, yet it has of late assumed a much greater importance in respect to navigation, since Captain Maury's western route across the equator has been advocated and followed; this importance will be increased if the idea is carried out of erecting a *lighthouse* on the reef to the memory of Captain Maury. It is also the more necessary to allude to the reef here, as a singular error in its position had been perpetuated till of late years, and which must have led to much embarrassment, and probably loss and danger. Yet the apathy of the seaman is exemplified in this, that among the thousands who must have passed it, and suspected the error, not one should have thought it worth while to question the accuracy.

This very dangerous group was examined, and their position accurately ascertained, by M. Lartigue, under the Baron Roussin, in 1825. Yet from an erroneous estimate in Horsburgh's Directory, the *first* edition, in 1809, they are placed in long. 33° 31′ W., or from *fifteen to eighteen miles too far East*. This error was continued in all the editions of Horsburgh down to that of 1855, and has doubtless misled many.

It was first pointed out by Lieutenant Lee, U.S.N., who visited it in the *Dolphin*, in April, 1852. He gives the following description of them.

The centre of this low and dangerous reef is in lat. 3° 51′ 27″ S., long. 33° 48′ 57″, and is 84 miles due West of the peak of Fernando Noronha. The reef extends about 1¼ mile in latitude, and nearly 1¾ mile in longitude, and is covered at high water, with the exception of Grass and Sand Islands on the West, and the scattered rocks on the South and East sides. These objects are from 15 to 10 ft. above the reef, which is formed of coral, generally level, though with many holes in it. In case of a vessel striking on the weather side of it (S.E.), the chance of saving life would be but small. When about 10 miles off, the breakers were first seen from aloft. Then the two low islands and the black rock soon appear. Sea birds abound, but there is no guano owing to the rains. The eggs of the gulls were plentiful

and good (March, 1851). There is no wood, nor fresh water. There is bad anchorage from 1 or 2 miles N.W. of Sand Island, in from 15 to 18 fathoms coral bottom. We found coral bottom at 15 fathoms, 6 miles East of the reef, but no bottom at 30 fathoms 2½ miles N.N.E., nor at 70 fathoms 4 miles S.E. of it.

The tide rises about 5 ft. The lagoon, in which we saw many turtle, has from 1 to 4 ft. water at low tide, and shows white from the mast-head at 4 or 5 miles distance. The anchors and cable on the S.W. part of the reef, and the remains of a wrecked vessel on the N.E. side of Grass Island, appear to have been on the reef for a long time. A lighthouse on the reef would be very useful to vessels.

The *current* in the vicinity of this reef sets from between S.E. by East, and East by North, at the rate of from ⅞ to 1½ mile per hour, as found by the patent log. The surface current found by trials on four different days, sets from between S.E. and East by North, from ⅞ to 1⅜ mile per hour. At the anchorage under the lee of Sandy Island, the tide ran from ¼ to ⅞ knot per hour, setting from between S.S.E. and East by North toward the northward and westward.

They were again partially surveyed by Lieut. J. E. Parish, in H.M.S. *Sharpshooter*, in March, 1856. He gives the position of the centre of the South Sand Island as 3° 51′ 25″ S., long. 33° 46′ 23″ W., or about 2 miles further East of Lieut. Lee's. Capt. Lartigue's longitude agrees with that of Lieut. Lee, and should therefore be preferred.

Lieut. Lee saw the remains of many wrecks on various parts of the banks, and a hut on the western edge; numerous cotton bales lie scattered about. A bank carrying 14 or 15 fathoms affords anchorage as far as 5 miles to the N.E. of the banks. Lieut. Lee planted some cocoa-nut trees on the eastern sand-bank, which would afford a useful mark if they grow. In 1870, the *Mercurius* was wrecked here, and the survivors state that there was only one of the trees remaining.

Captain Dumaresq, of the *Innisfail*, from Bahia, reports as follows:— "October 9th, 1872, sighted the Rocas Reef, passed very close on the West side. Observed by bearings, in coming from the southward, that the reef is longer from East to West than reported in the Sailing Directions. It appeared at least about 3½ miles, and from North to South about 2 miles. Saw white bottom at about half a mile off the West end, but no breakers. A few trees were growing on the South islet, about 10 ft. high, and were distinguished from aloft before the hut on the northern islet could be seen about 10 miles off. I am of opinion that nothing of the reef could be seen on a fine night at a mile off, unless from the whiteness of the water on the reef and lagoon."

Fernando Noronha and the adjacent coast of Brazil are described in our Directory for the South Atlantic Ocean.

The *current* between the Rocas and the main sets generally from the southward and eastward, from 1 to 1½ knot, until near the flats, where we experienced indications of a counter current or tide. Learned at Para that their coasting vessels were generally four weeks going from there to Per-

nambuco. It is more from the failing of the wind there than from the current, that it is so difficult to double Cape San Roque.

CAPE SAN ROQUE, in lat. 5° 28′ 20″ S., long. 35° 16′ 18″ W., is considered as the turning point of the Brasilian coast. The *Shoals of San Roque* extend between the Cape and Toiro or Touro Point, 23 miles to the N.W., at a distance of from 6 to 8 miles off shore, the outer edge being in some places awash. The N.W. point is 9 miles N.N.E. from Point Toiro, and the S.E. end 4½ miles E. by N. from San Roque. There are several channels through this outer line of reefs, and within it is a channel of 3½ to 5 fathoms throughout, except a *bar* of 13 to 14 ft. midway between Cape San Roque and Point Toiro. The charts will show the peculiarities of this important point.

13.—THE COASTS AND ISLANDS OF AMERICA, IN GENERAL.

For a complete and direct description of the Coasts of Newfoundland, of the Gulf and River of St. Lawrence, the Coast of Nova Scotia, &c., to Cape Cod, the reader is referred to the "British American Navigator," published by the proprietor of the present work. The navigation thence to the southward, including the whole of the West Indies and Mexican Sea, is described in "The Columbian Navigator."

The American navigation, in general, requires details so minute, and explanations so copious, as to render it impracticable to do justice to the subject in an abridgement. It will, therefore, not be attempted. A few remarks on the principal ports only will be added.

In the preceding pages the various phenomena which control the passages across the Atlantic are recited, and with those remarks are many concerning the proper mode of approaching any port. In connection, therefore, with what follows, these previous directions may be incorporated.

The **NEWFOUNDLAND BANKS**, which have been in their fisheries the source of all the opulence in the island, are vast submarine elevations, of various depths and very unequal figures. The depths on the Great Bank vary from 15 to 80 fathoms. The quality of the bottom varies considerably, but it generally consists of sand, or sand mixed with shells and gravel, rarely with stones. The eastern face of the bank is clear sand, white or whitish, and often sparkling. In the gullies and deeps which separate the bank, and more particularly in the Whale Deep or Trou de la Baleine, the bottom is found to consist of mud or oaze with a fœtid smell, and abounds with different sorts of fish, but more particularly with cod, which is inconceivably numerous; for, although from 200 to 400 vessels have been annually freighted with this article of commerce for nearly two centuries, there appears to be no sensible decrease of the former plenty. A great swell and thick fog usually indicate the place of the bank.

There are, generally, in the spring, within 125 or 130 leagues of the land, and between the Outer and Grand Banks, numerous icebergs, or ice-islands, that float down with the current from the north-westward, and which, during the foggy weather, are very dangerous. Even in the months of

June, July, and August, there are frequently a number of them; some of which may be seen aground, in 40 or 50 fathoms of water. In thick weather, the place of these may commonly be distinguished by the *ice-blink*, a brightness of the sky above them; or by the breaking of the sea against them, which may also be heard at a considerable distance; or by the decrease of the temperature of the water, as shown on page 432.

On approaching toward Cape Race (the S.E. point of Newfoundland), be careful to avoid the *Virgin Rocks*, a dangerous reef, lying 20 leagues S.E. $\frac{3}{4}$ E. (*E. by S.*) from that cape. In gales of wind a heavy sea breaks over them; and a strong current, which sets about them, often increases the danger.

The bank, on which the shoal is, extends E. by N. and W. by S. $4\frac{1}{4}$ miles; its broadest part is about $2\frac{3}{4}$ miles. The soundings are regular from 28 to 30 fathoms, but deepen suddenly on the outer edge to 39 and 43.

The rocks themselves are in 46° 26′ 30″ N., and 50° 51′ 30″ W. They extend in an irregular chain, S.W. by W. and N.E. by E. 800 yards, varying from 200 to 300 yards in breadth. The least depth of water is on a white rock, in $4\frac{1}{2}$ fathoms, with 5 to $6\frac{1}{2}$ fathoms all round it; the bottom distinctly visible. Toward the extremities of the shoal are several detached rocks of from 7 to 9 fathoms, with deep water between, and with a current setting over them W.S.W. 1 mile an hour, and with also a very confused heavy swell.

It is said that "A shoal, with only 21 feet water upon it, was discovered by Jesse Ryder, master of the fishing schooner *Bethel*, on the Grand Bank of Newfoundland, in lat. 46° 30′, a rock of about 100 or 200 feet surface, about 50 miles East of the Virgin Rocks. Shoal bears from the Nine Fathom Bank S. by W. by compass about $1\frac{1}{2}$ mile; discovered it accidentally, while searching for the Nine Fathom Bank, to fish on. I afterwards saw the Virgin Rocks."

Another shoal, breaking at times, was reported in 1859 by Captain Kewley, of Glasgow, to lie 4 or 5 miles S.W. of the Virgin Rocks.

Ships bound to *St. John's* are, therefore, recommended to keep on the parallel of 46°, or a degree and a half to the southward of the parallel of that port, and until they approach the outer edge of the Great Bank; and, when they obtain soundings, to steer directly to the south-westward for Cape Spear, the position of which is given as 47° 31′ N. and 50° $36\frac{1}{2}$′ W.; but see also pages 516 *et seq.*

The **HARBOUR OF ST. JOHN'S**, which is the principal harbour of Newfoundland, is an excellent one. It was surveyed by Captain Orlebar, R.N., in 1862. The entrance is through the "Narrows," a strait running in a N.W. by W. direction about half a mile long, and 220 yards across in the narrowest part, with rocky precipitous heights of 500 feet on each side. There are from 9 to 16 fathoms of water in the middle of the channel, with tolerably good anchorage ground. The harbour then opens by a turn at right angles, and runs in a S.W. direction for a mile and a quarter, and in front the city of St. John's appears climbing up a hill, from Fort William to Fort Townsend, now dismantled. In close proximity to this fort is seen the Roman Catholic Cathedral, the English Cathedral, and the churches of the Kirk and Free Kirk of Scotland, the Wesleyan and Congregational

Chapels. The ridge of hills on the S.E. side of the harbour is 740 ft. high, and on the opposite side of the Narrows is a continuation of the same ridge, called Signal Hill, 520 ft. high, to which place all vessels are telegraphed from Cape Spear on their first appearance off that place. At two-thirds the distance from the entrance to the harbour itself, is a rock, on the North side, called the *Chain Rock*, which with *Pancake Island* on the opposite shore, contracts the entrance at this part; and between them a chain used to be stretched to prevent the entrance of any hostile fleet. There are batteries on the more prominent points of the Narrows, Fort Amherst on the South Head, and Frederick's Battery, 2 cables' lengths to the westward. Opposite to the latter, on the North shore, is the Queen's Battery, on the hill, 390 feet above the sea; and on the point adjacent to the Chain and Roby Rocks is another battery.

Lights.—On Fort Amherst, on the South side of the entrance, a *bright fixed light* is shown, at an elevation of 114 ft., visible 16 miles off. It is from a 4th order lens apparatus. A fog signal-gun is fired every hour during daylight in thick weather.

Two *fixed red* lights, one placed on the roof of the Custom-house, at 50 ft. above the sea, the other near the Congregational Chapel in front of the Cathedral, 225 ft. above the sea. They are 2 cables distant from each other, and when in line bearing N.W. $\frac{3}{4}$ W., lead through the Narrows.

A *Fog-trumpet* is established at Cape Spear lighthouse station, to the southward of the entrance of St. John's Harbour, which, during thick weather, will give blasts of 7 seconds duration once in every minute.

The *City of St. John's* is the principal settlement, and the only considerable town in the island. It is the seat of government and the bishopric, and the chief harbour for the British vessels.

The entrance to the harbour, as above stated, lies N.W. by W., and within will be found to narrow; as, in the inner part, there is a rock on each side, but above water. Here the breadth of the channel is only 95 fathoms, and the depth 9. When past these rocks you may run on boldly without any fear of danger, only avoiding a rock on the South side, called *Prosser's Rock*, on which there are only 9 ft. of water.

About 20 fathoms to the southward of the *Chain Rock*, which is always above water, is the *Roby* or *Salisbury Rock*, on which the U.S. steam-frigate *Niagara* struck after landing the electric cable in Trinity Bay. It is to be (or is) deepened. The same with the *Merlin Rock* inside the entrance, which has been blasted to 27 ft. least water.

Within the harbour you may anchor in any depth from 4 to 12 or 14 fathoms, land-locked from all winds, as the harbour within the Narrows lies W.S.W. It is however to be noticed that there is no possibility of sailing in, unless with the wind from S.W. by S. to East. The wind from S.W. to N.E by N. blows out of the Narrows. Here ships must then anchor and warp in, for which purpose there are rings in the rocks on both sides.

The city extends along the western shore to the head of the harbour, and has an extent of more than a mile of water frontage, which is chiefly remarkable for its fishing stages. The head of the harbour to the S.W. is a shallow lake, on the eastern side of which is the Admiralty yard, &c. Lower down the harbour is a floating dock.

The entrance of St. John's Harbour is readily known by the block-house and *Signal-station* on Signal Hill on the North Head, and Amherst Fort with its light on the South Head. There is a sunken rock, called the *Vestal*, 50 fathoms without South Head, with only 12 ft. of water on it. This rock is about 10 fathoms long and 7 broad; the marks for it are, Fort William (which stands within the harbour on the North side) open of South Head, bearing N. 39° W.; and the outer *Wash-ball Rock* open with Cuckold's Head, bearing N. 47° E. The Wash-ball Rocks join the North Head; they are all above water and steep-to, therefore not dangerous. A mark for approaching the Narrows is the South Head touching the Chain Rock battery, bearing N.N.W. ½ W. The course in the Narrows is N.W. by distance 370 fathoms to Chain Rock on the North, and the Pancake on the South side. Both these rocks are above water, and steep-to. Sixty-five fathoms within the Pancake Rock, on the South shore, lies the *Little Pancake*, a rocky shoal, dry at low water; and 80 fathoms within the latter lies a sunken rock, called Prosser's Rock, running off 30 fathoms from a rock above water, in the form of a saddle, with 11 ft. of water in the hollow, and only 5 ft. on the outside. It is steep-to, with 5 fathoms close to it. After you have passed Prosser's Rock you may stand to either shore, as they are clear and steep-to. You may anchor in what water you please from 8 to 4 fathoms, muddy bottom.

The tide of St. John's sometimes rises 7 or 8 ft.; it is not regular, but greatly influenced by the wind.

At half a mile S.E. ¼ S. from Fort Amherst is the centre of a narrow bank, having 14 fathoms over it, and which breaks in rough weather. It extends nearly a quarter of a mile N.E. and S.W., and has on it, near each end, a depth of 20 fathoms.

Is is high water in the harbour, on the full and change, at $7^h\ 30^m$. Spring tides rise 6 ft., neaps 4 ft.

Be very cautious, if unacquainted with the coast, that you mistake not the place called *Quidi Vidi* (or *Kitty Vitty*), a mile to the northward, for the harbour of St. John's, as it shows an opening like a good harbour, but it is fit only for boats, and not safe even for these at low water. *Fort Amherst*, which stands on the South head of St. John's, appears white, and the flag-staffs on the hill, over the North Head, will point to the Harbour of St. John's. Besides these, the course from *Cape Spear* is N.N.W., and the distance about 4 miles. The position of Fort Amherst is lat. 47° 33½′ N., long. 52° 40′ W.

CAPE RACE LIGHTHOUSE is 40 ft. high, and is striped red and white vertically on the S.E. face. The light is a *revolving bright light*, with a flash every minute at 180 ft., visible 19 miles off. It is visible to seaward from E.N.E. round southward to W.S.W.

A conical beacon stands 50 yards South from the lighthouse, and a *telegraph station* North 240 yards from the lighthouse. This telegraph will communicate with passing vessels.

The land about Cape Race is comparatively low, and bare of wood, with a steep cliff of about 50 ft. in height. As a landfall it is somewhat dangerous on account of the fogs to the eastward, and in the season of ice-drifts the bergs and fields are frequently very numerous about it. A southerly

course may therefore be preferable. On this topic the following remarks by Captain Orlebar, R.N., are important:—

"Although the current between the Grand Bank and Newfoundland commonly sets to the W.S.W., sometimes at a rate of nearly 1 mile per hour, it is not always so, and near the shore in moderate weather it even changes with the tide. At these times during the flood it runs to the S.W., and during the ebb to the N.E., the former being the stronger. Westward of Cape Race it must also be remembered that the current so frequently setting to the N.W., 1 mile per hour in the offing, is not invariable in strength or direction, but is affected greatly by the prevailing wind. It is observed generally to run in upon the eastern side of the great bays indenting the South coast of Newfoundland, and out on their western side. In the offing it is influenced by the winds, and near the shore it is also altered and influenced by the tides; so that during spring tides the stream of ebb runs weakly to the S.E., and the stream of flood to the N.W, the latter sometimes 2 miles per hour round the headlands.

"Vessels coming from the eastward in thick weather, if sounding carefully, will probably strike the Ballard Bank, which is parallel to the shore and about 15 miles long, varying from 1 to 5 miles across. A careful comparison of the soundings thus obtained with those on the chart, will show the position of the vessel with sufficient accuracy to enable the navigator to round Cape Race without danger.

"For instance, if after sounding in about 80 fathoms, and one cast of comparatively shoal water, that is from 30 to 40 fathoms should be obtained, and afterwards the depth increases to 40, it may be concluded that the vessel has passed over the narrow part of the Ballard Bank, and is to the northward of the cape, and the course should be changed accordingly.

"But if shoal water under 30 fathoms continue for 5 miles, and then deepens slightly, and again becomes shoal, the vessel may be safely concluded to be on the southern part of the bank, and therefore South of Cape Race, and her course to the westward may be continued with confidence.

"A vessel from the westward in thick weather may round Cape Pine and Cape Race with perfect safety, if only attention be given to the lead. The water shoals gradually to the shore, and at the distance of 10 miles there is not more than 40 fathoms, so that maintaining a depth of more than 30 fathoms no risk can be incurred.

"It is to be regretted that there is no well-marked difference in the nature of the soundings off these headlands that would show the position of a vessel, the bottom being generally rock, with shells of the sea-egg, gray sand and small stones predominating."

Cape Pine, with its iron lighthouse and fixed light, stands as is shown in the table, in lat. 46° 37′, long. 53° 31′ 45″, and at a short distance westward of it is the famous (in former times) *St. Shot's Bay*, alluded to in the account of the wrecks in (318), page 429.

The *currents* hereabouts are described on pages 429—432; the *winds* on pages 256-7; and the *tides*, on pages 301, 309.

A general description of the *passages* towards Newfoundland and into the Gulf of St. Lawrence, are given on pages 516—523.

The distinctive features of the coast eastward of Halifax are often not

perceived in the usual weather, at the distance which the outlying dangers render it prudent for a vessel to be kept from the shore. The lighthouses, however, which are fully described in the tables, afford great assistance to a stranger in ascertaining his position when first making the land.

The principal banks lying off the S.E. coast of Nova Scotia are the *Banquereau* and *Sable Island Banks*, which are each about 150 miles in length, and extend to an equal distance from the coast.

Sable Island and its *Banks* have been described on page 753.

HALIFAX HARBOUR, one of the finest in the world, affords space and depth of water sufficient for any number of the largest ships with safety; and although the dangers off its entrance are such as to render great caution necessary, especially in the fogs which usually accompany all winds from the sea, it is yet easier of access and egress than any other large harbour on the coast. It is 5½ miles wide at its entrance, from Chebucto Head on the S.W. to Devil Island on the N.E., and it continues inland 15 miles, in a northerly direction, to the head of Bedford Basin. The City of Halifax, the capital of Nova Scotia, containing not less than 25,000 inhabitants, stands on the declivity of a peninsula on the western side of the harbour, and 8 miles above Chebucto Head. The citadel, immediately in rear of the city, is elevated 227 ft. above the sea at high water, and with its flagstaff forms a leading mark easily recognised from a vessel off the entrance of the harbour.

Lights.—Three lighthouses denote the entrance to Halifax Harbour. One on the western side, placed on Chebucto Head, shows a *revolving light*, the purpose of which is to guide vessels clear of the dangerous Duncan Reef and Bell Rock, lying southward of Chebucto Head. On the eastern side of the entrance two *fixed bright lights* are shown on Devil Island, which, when in one bearing E. ¾ N., lead southward of the dangerous Thrum Cap Shoal, which shoal is also cleared to the westward by keeping George Island lights (*two bright lights*, vertical, 20 ft. apart) open westward of Maugher Beach light (*fixed bright*). Care must be taken not to mistake two lights shown on the citadel, at an elevation of 240 ft., for George Island lights, the highest of which is only elevated 50 ft. More particulars of the above lights will be found in the Table of Lighthouses, or in the Sailing Directions which accompany the chart of the Coasts of British America, published by the proprietor of this present work.

Fog Signals.—During thick weather the entrance to Halifax Harbour is well denoted by the steam fog-whistle on Sambro Island to the southward, and also by two automatic whistle buoys,* one of which, painted *black*, lies well outside the entrance to the harbour. It is surmounted by a 10-inch whistle, and moored in 36 fathoms water, with Sambro Island lighthouse W. ⅓ N., distant 8⅓ miles, and Chebucto Head lighthouse N.W. by W., 6¼ miles. Position, lat. 44° 28′ 25″ N., long. 63° 22′ 10″ W.

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* The whistles of these buoys are sounded by the exit of compressed air from a 20 or 30-inch tube, 20 or 30 ft. in length, attached to the buoys. The air is compressed by means of the motion of the buoy, so that in a very smooth sea not much dependence is to be placed on them.

Having passed this outer buoy when bound into Halifax, a N.W. ½ N. course for 6 miles will lead to the inner automatic buoy, which is painted *red*, and moored in 21 fathoms water, with Chebucto Head bearing S.W. ½ W., distant 1¾ mile, and Sandwich Point N. by W., 4 miles. After passing westward of the inner signal buoy at the distance of about half a cable, a N. ¼ W. course will lead up the harbour, eastward of Neverfail Shoal, and westward of Maugher Beach lighthouse. When approaching Maugher Beach, a good look-out should be kept for the fog-bell on the lighthouse, which is sounded (by machinery) seven times *every minute*.

On nearing the automatic buoys in thick or foggy weather, the lead will verify the vessel's position.

Pilots are stationed on Devil Island, and several families reside there.

Directions.—The bank off Sambro Island, terminating in a point, and at the depth of 30 fathoms, 5 miles South of the Sambro Ledges, offers considerable assistance to vessels approaching Halifax from the westward in thick fogs, which so frequently prevail. From the eastward the approach is rendered comparatively easy, by the absence of outlying dangers after passing Shut-in Island, and by the soundings deepening out with tolerable regularity to 30 fathoms, at distances varying from 4 to 6 miles from the shore, until within 2 miles of Chebucto and White Heads, where the depth exceeds 30 fathoms, until within one-third of a mile from the shore. Attention to these soundings, combined with the fog-signals above described, may enable steamers at times to enter the harbour notwithstanding the fog, but it is seldom prudent for a large sailing vessel to attempt it under such circumstances.

Captain Dunsterville writes thus:—"In approaching the land of Nova Scotia, do not come into less than 50 fathoms, for though there may be a dense fog in the offing, yet near and over the land it is frequently clear, therefore by sounding frequently, you may, even in a fog, approach the coast; and if you suppose yourself near Sambro' lighthouse, by firing a gun, a pilot will very soon offer. The lighthouse is remarkable, and may be seen from seaward at 3 or 4 leagues off. The land about Halifax is of moderate height, and may be seen at about 6 leagues. Citadel Hill, over the town, may probably be seen much further; this is where the signal is made for all vessels in the offing. The light on Maugher's Beach kept between N. by E. and North, will lead you clear to the westward of Thrumcap, which is a most dangerous shoal. Chebucto Head lighthouse, bearing N.W., clears all the dangers lying to the S.W. It is worthy of observation, that, in approaching the land near Halifax, in thick weather, when it is just perceptible, the colour of the cliffs eastward of the harbour is *red*, and to the westward *white*."

From the WESTWARD *at night*.—In approaching Halifax Harbour from the westward at night, shape a course to pass not less than 3 miles to the southward of the Sambro Island light, steering E.N.E., and in not less than 30 fathoms water, until the light bears North; when, if not more than 6 miles from it, the vessel will have arrived at the southern prolongation of the Sambro Bank. Having crossed the bank into deep water, haul up N.N.E, until the light on Maugher Beach opens out East of Chebucto Head, bearing N. by E., when steer for it, keeping well outside the black buoy marking

Bell Rock, or so as to pass within a mile or less from Chebucto Head, which is quite bold. Having done so, keep the light bearing between North and N. by E., as the vessel runs towards it, and all the dangers will be avoided except the Neverfail Shoal, on which there is not less than 4½ fathoms.

Having arrived abreast the Thrumcap, or brought Devil Island lights in line E. ¾ N., the western side of Thrumcap shoal will be cleared by keeping George Island lights open westward of Maugher Beach light as before described. Alter course, as may be necessary, to avoid the Lighthouse Bank; and as soon as the light on Maugher Beach bears East, steer N. by E. for Ives Point (or N.N.E., if necessary, to avoid the Middle Ground, on which, however, there are not less than 4½ fathoms), until the light bears S. by E.; then a N. by W. course, keeping the light astern, will lead between the Pleasant Shoal and Reed Rock *black* buoys on the one side, and Ives Knoll red buoy on the other into the harbour. Having passed Ives Knoll, the vessel may proceed in on either side of George Island, or may anchor in the stream of Macnab Island until daylight, according to circumstances. The light on Maugher Beach disappears behind Ives Point, as a vessel runs in to the eastward of George Island, which is the wider and preferable channel in a dark night. Within George Island there is nothing in the way, excepting the Dockyard Shoal, and the shallow water off Dartmouth.

By Day.—Approaching from the westward in the daytime, pass Sambro Island Lighthouse at the distance of 3 or 4 miles, and when Sandwich Point opens out East of Chebucto Head, stand in N. by E. or N.N.E., according to the wind, until the citadel flag-staff opens East of Sandwich Point, bearing N. ½ W. Keep the citadel flag-staff only just open, running towards it, and it will lead between the Lichfield (marked by a *black* buoy) and Neverfail Shoals, and up to Mars Rock *black* buoy, which leave to the westward. Having passed Sandwich Point, from which the shallow water does not extend beyond a cable's length, steer towards George Island, keeping Chebucto Head only just in sight East of Sandwich Point until the vessel has passed close to the westward of the Middle Ground; then open out the head more, so as to leave the Pleasant Shoal and Reed Rock *black* buoys to the westward, in running towards George Island; or, if it be preferred, the steeple at Dartmouth in one with the eastern side of George Island, bearing North, will lead to the eastward of the Middle Ground. Either of the marks just given will lead clear up to George Island, on either side of which the vessel may pass into the harbour, leaving the Belleisle and Leopard buoys to the westward, if she passes between them and the island, and choosing her anchorage off the wharves of the city, or off the Dockyard, where the Commissioner's Buoy will point out the Dockyard Shoal.

From the EASTWARD *by night.*—Approaching from the eastward by night, and being to the westward of the Jedore Ledges, run along the land in a depth not less than 30 fathoms, until the lights on Devil Island are seen; then, if it be intended to pass to the southward of the Rock Head and Portuguese Shoal (the former marked by a black and white striped buoy, and the latter by a red and black banded buoy), steer for Chebucto Head until near the Whistle buoy (remembering that to clear the Rock Head, the light

on Sambro Island must be kept wide open to the S.E. of White Head, bearing nothing to the southward of S.W. by W.; and the lights on Devil Island nothing to the eastward of N.E. by N.), until the light on Maugher Beach bears North; when steer for it, keeping it bearing between North and N. by E., and proceeding as already directed.

By day steer for Chebucto Head until the citadel flagstaff is only just open East of Sandwich Point, N. ½ W.; then steer for it, and proceed as before.

Between the Rock Head and Thrumcap.—If a N.E. wind, or other circumstances, should render the passage preferable between the Rock Head and Thrumcap Shoals, proceed as follows:—

By night.—Having passed Shut-in Island, steer so as to pass not less than half a mile, or more than one mile, to the southward of Devil Island. Having passed Devil Island, the high light on the South end of that island, bearing E. by N. and open southward of the low light, will clear Thrumcap Shoals. From a position a mile southward of Devil Island, steer to the westward, until the light on Maugher Beach bears North, when proceed as before directed. A large vessel should not use this channel at night.

From Halifax, westward, to Margaret Bay, the country appears, from the offing, very rocky and broken; the shore is steep-to, and bounded with white rocky cliffs. The high lands of Aspotogen, on the eastern side of Mahone Bay, are most remarkable; the summit is very conspicuous; it is 483 ft. high, and may be seen at the distance of 7 or 8 leagues. Proceeding westward from Mahone Bay, the rocks which surround the shore are black, with some banks of red earth. *Cape le Have* is an abrupt cliff, 107 ft. high above the sea; it is bald on the top, with a red bank under it, facing the south-westward. Between this cape and Port Metway there are some hummocks within land, about which the country appears low and level from the sea; and on the shore, white rocks and stony beaches, with several low bald points; hence to Shelburn Harbour the land is woody. About the entrance of Port Latour, and within land, are several barren spots, which, from the offing, are easily discerned; thence, to Cape Sable, the land appears level and low, and on the shore are some cliffs of exceedingly white sand, particularly in the entrance of Port Latour, and on Cape Sable, where they are very conspicuous from the sea.

From Sambro' Lighthouse to Cape Sable extremity, the bearing and distance are W. by S. ½ S. 112 miles.

Cape Sable is the cliff of a sandy islet distinct from Cape Baccaro; it is white, broken, evidently diminishing, and may be seen at the distance of 5 leagues. The lighthouse, which is white, and 50 ft. high, shows a *revolving light,* and has a *Fog-whistle,* as described in the Table of Lighthouses. From the islet ledges extend outward, both to the East and West; the eastern ledge, called the *Horse-shoe,* extends 2½ miles S.E. by S.; the western, or *Cape Ledge,* extends 3 miles to the S.W. The tide, both ebb and flood, sets directly across these ledges, the flood westward. The ebb, setting with rapidity to the N.E., causes a strong break to a considerable distance from shore. This coast should not be approached without a commanding breeze and clear weather. Here the tide runs at the rate of 3, and sometimes 4, knots; and when the wind blows fresh, a rippling extends from the breakers

soutnerly to the distance of nearly 3 leagues, and shifts its direction with the tide; with the flood it is more westerly, and inclines to the eastward with the ebb. This ripple may be dangerous to pass through in a gale, as it has the appearance of high breakers, although there is no less than 8, 10, 12, and 20 fathoms of water, rocky ground. At the Cape, the tide, on full and change, flows at 8^h, and rises 9 ft.

Brasil Rock is a flat rock, covering an area of about 10 yards, and having 11 ft. over it at low water, in calm weather; within a hundred yards from its base are from 6 to 8 fathoms water; to the southward, at about a mile from the rock, the depths are from 18 to 20 fathoms, but toward the shore the soundings are regular, 15 to 19 and 20 fathoms. The tide, by running strongly over the shoal ground, causes a great ripple, and makes the rock appear larger than it really is. From Cape Negro the bearing and distance to the rock are S.W. $\frac{1}{4}$ S. 10 miles; Cape Baccaro Light, S. $\frac{3}{4}$ W. $5\frac{1}{2}$ miles; and, from the rock, Cape Sable Lighthouse bears N.W. by W. 8 miles. Its given position is, lat. 43° 21′ 50″, long. 65° 27′.

Seal Island.—The southernmost point bears from Cape Sable nearly W.N.W. $\frac{1}{2}$ W., 17 miles. The *lighthouse* stands half a mile from the South end, showing a fixed light at 98 ft.

At about $3\frac{1}{2}$ miles S. $\frac{1}{4}$ E. from the lighthouse on Seal Island lies the *Blonde*, a rock uncovered at low water. Close around it are from 7 to 10 fathoms. Within a mile westward from the Blonde are heavy and dangerous overfalls, which present an alarming aspect. At $4\frac{1}{2}$ miles North from these is a bed of shoal ground, of 16 ft. causing a violent ripple.

Off the West side of Seal Island is the rocky islet called the *Devil's Limb*, which may at all times be seen.

The navigation of the *Bay of Fundy*, with its furious tides, requires extraordinary caution, and any space we could afford here would be of little service in explaining its nature.

The *Coast of Maine*, also, is so intricate, its inlets so numerous, and fronted by almost innumerable rocks and islets, that a lengthened description would only suffice to explain its character. The lighthouses on the outlying rocks of *Mount Desert* and *Matinicus*, *Manheigan Island*, &c., will show the outer limit of this labyrinth, and further description will be found in the Directions for the chart of the coasts of British America.

BOSTON.—From Seal Island Lighthouse to the entrance of Boston Harbour, the direction and distance are W. $\frac{1}{4}$ S. 220 miles, but it should be remembered that the dangerous rock on *Cashe's Ledge* is just to the northward of this course.

The lighthouses of Cape Anne, and those on the Cape Cod Peninsula, described in the list, are the most prominent points in approaching Boston.

From the Egg Rock Lighthouse off Nahant Peninsula to Minot's Ledge Lighthouse, on one of the Cohasset Rocks, the bearing and distance is S.S.E. 12 miles, and in this interval are the various entrances to the extensive series of channels and bays which collectively form the harbour of Boston.

The assistance of a pilot is always necessary, and this cannot be too strongly insisted on, for, notwithstanding that the principal dangers are beaconed and buoyed, and the points of approach well lighted, yet it

should never be attempted without either an exact knowledge or with the aid of a competent pilot.

Boston Lighthouse.—The principal lighthouse is on *Little Brewster Island*, on the North side of the principal entrance, in lat. 42° 19′ 39″ N., and long. 70° 53′ 5″ W. It is a white circular tower 80 ft. in total height, showing a brilliant revolving light every half minute, elevated 111 ft., visible at 16 miles off. *A Fog-trumpet* is sounded in foggy weather, giving blasts of 7 seconds at intervals of 43 seconds.

Minot Ledge Lighthouse is 6⅔ miles S.E. ½ E. from the Little Brewster Island Lighthouse, and stands on the outermost of the Cohasset Rocks. It was originally an iron pile structure, which disappeared during a heavy storm, and was succeeded by the present dark grey granite tower, 100 ft. in total height, and showing a brilliant fixed light at 92 ft. above the sea, visible 15 miles off. A *Fog-bell* is sounded when necessary.

The Narrows Light, on the West end of the Brewster Spit or Bar, abreast the Narrows, is a *red fixed light*, exhibited from a screw pile lighthouse, and may be seen 7 miles off. It bears westward 1¼ mile from the Boston Lighthouse.

Long Island Lighthouse is a white iron tower 22 ft. high, on the N.E. end of Long Island, on the South side of President Road. The light is fixed, elevated 80 ft., visible 15 miles off.

DANGERS.—The *Graves* are a parcel of dry rocks which appear white, lying to the northward and eastward of Boston Light. On the N.E. ledge is an iron *bell-boat*, in 10 fathoms water, Long Island Light bearing W.S.W. ½ W., 4¾ miles distant, and Boston Light S.W. ½ S., 2¾ miles distant.

Thieves Ledge, of 4½ fathoms, lies E. ½ S. of Boston Light, distant 3 miles.

Harding Ledge is dry at low water, and on the drying part a shaft is raised, having on its summit, which is 31½ ft. above low water, a cast-iron ring, set horizontally, with twelve wooden pendants attached to the rim. This beacon is entirely black, and from it Boston Lighthouse bears N.W. 2¼ miles; Martin's Ledge, North, 2½ miles; and Minot's Ledge Lighthouse, S.E. ½ E., 4½ miles. A *black bell-boat* lies off the N.E. side of the ledge.

Martin Ledge lies nearly midway between Thieves Ledge and the Graves, and has on it 13 ft. at low water. Outside the ledge, in 6 fathoms, there is a *red* nun buoy.

Directions.—Coming from the vicinity of Cape Cod, you should keep to the northward of the direct course, if the wind is N.E.; and to the westward if it is S.W., making allowance for the tide. With a leading wind a direct course may be made good on the flood; but the ebb sets toward Minot's Ledge Light.

If from the vicinity of Cape Ann, no particular precautions are necessary.

Should you fall in with the Scituate land, in a depth of 10 or 12 fathoms, without having seen the light on the Cohassets Rocks during the night or thick weather, run North into 17 or 18 fathoms, and steer W.N.W. for Boston Light. From the lighthouse on the Cohassets Rocks, Boston Lighthouse bears N.W. ½ W., distant 7 miles. David's Ledge lies E. by S. ¼ S. from Cohasset's Lighthouse, and has a buoy placed to the N.E. of it to mark the danger.

When near the land, and approaching Minot's Ledge, bring the point of Scituate to bear South, and steer North, which will clear Davis's Ledge,

three-quarters of a mile to the eastward; and when you get the lighthouse on the Cohassets Rocks to bear West, steer N.W. by W. for Boston Lighthouse, which will lead to the N.E. of the bell-boat on Harding's Ledge; but in thick weather it is more prudent to steer N.W. until up with the bell-boat, bearing West, then W.N.W., allowing for wind and tide. From off Nahant Head, and bound for the main ship channel, bring the light on the Egg Rock to bear N.N.W., and steer S.S.E. to pass the Graves, at half a mile to the eastward of the bell-boat riding on them, and when it bears N.W. by W. ½ W., steer S.S.W. until up with the bearing for entering the channel. Vessels may pass inside the Graves, keeping 1 cable's length from the S.W. point.

Vessels working to windward in Boston Bay up the harbour, may, in the daytime, stretch safely anywhere between Minot's Ledge and Nahant Head until up with the Graves on one side and Harding's Ledge on the other. Do not come nearer the N.E. part of the Graves than half a mile, but the Hardings may be approached pretty near to the bell-boat. Inside of the line from the Graves to the Hardings you may stand to the southward to within half a mile of the shore, and to the northward to within three-quarters of a mile of the East end of the Outer Brewster, or the East end of the Shag or Egg Rocks.

When up with the Egg Rocks, you must stand no farther to the northward than to bring Boston and Long Island Lights in range, and in passing Point Allerton be careful not to go inside the buoy. A vessel, not having a pilot, even if a stranger, may beat up to the anchorage inside the lighthouse, in the daytime, by making short boards, and keeping 2 cables' lengths from Lighthouse Island, but should wait there for a commissioned pilot. If you are working up for Boston Harbour in the night, you will avoid the Cohassets and Harding's Ledge by not standing farther to the southward than to bring Boston Light to bear W.N.W. When within 2 miles of the light, go no nearer than to bring it to bear West, and when near Egg Rocks you must not pass to the North of Boston and Long Island Lights in range.

Main Ship Channel.—When abreast of the lighthouse, bearing North, and in mid-channel, a W. ½ N. course made good leads to the pilo lighthouse on the spit; but if the tide is ebb, or you are on the North side of the channel, steer West or West-southerly, so as to avoid getting on the False Spit. Leave the lighthouse on the starboard hand, and steer N.W. ½ W. past George's Island. In this course you will have Nix's Mate Beacon and the middle of Bunker Hill Monument in range until up with the eastern end of Gallop Island. From this point the course through the Narrows is N.W. by N., keeping in mid-channel and steering for the high land on Deer Island until up with Nix's Mate, which leave on the port hand.

When you are passing Nix's Mate you should have Deer Island Beacon on the N.E. end of Apple Island for a light ship, and off the South part of Apple Island for a vessel of heavy draught. By observing either of these marks, you will avoid the shoal ground about Nix's Mate. A W. ½ N. course leads from Nix's Mate through President Roads, until the new beacon on the high part of Long Island is just clear of the N.E. bank of Spectacle Island, when the course is N.W., keeping the marks astern in range until abreast of the beacon on the S.E. part of Bird Island.

In steering this latter range, it will lead safely past the Lower Middle, Castle Island Rocks, Governor's Island Point, the Upper Middle, and in the best water over the shoal ground above the Upper Middle. When up with the beacon on Bird Island, steer N.W. by W. ½ W. towards the State House, until abreast of the buoy on the Slate Ledge, and then N.W. by N. for the anchorage.

Hypocrite Channel is between the Outer Brewster on the South, and the Sunken Rocks to the northward, thence between the Green and Little Calf Islands to Ram Head, where it joins the Broad Sound Channel. This channel is intricate, and only fit for those acquainted with it, and therefore not to be attempted without a pilot.

Black Rock Channel leads from the main ship channel at the pile lighthouse into the Hypocrite Channel, and is never used by large vessels except in the winter time, to avoid the ice in the Narrows. This channel, too, is narrow and dangerous, and not fit for strangers to attempt.

Broad Sound Channels.—The South: Vessels intending to enter by the South Channel may stand in anywhere between Nahant Head and the Graves, and steering to the South of West, until they bring Nix's Mate Beacon to bear S.W. by W. ¼ W., may run for it.

The mark for this channel is Nix's Mate, in the middle of the northern and highest of the Blue Hills. This channel is short and straight; its range is perfect, and is safe at half or three-quarters flood for the largest ships; especially for vessels outward bound. Vessels going out this way will leave Ram Head, Aldridge's Ledge, and Devil's Back Buoys on the starboard hand, and the Little Faun and Great Faun Beacon on the port hand; and in running out of Broad Sound will keep Egg Rock open with Nahant Head.

The *North Channel* passes nearer Deer Island, and is separated from the South Channel by a middle ground. The buoys are passed in the same way as in the latter. The range for this channel is the North head of Long Island (on which the lighthouse stands), in line with the second bluff on the West side. This channel cannot be recommended, and should not be attempted in bad weather, even by small vessels.

There is another channel out, used by vessels in light winds on the ebb, to prevent being set into the Sound at Nix's Mate, or the East end of Lovel's Island. This is to the southward of President Roads, Spectacle Island, and Long Island, and through Nantasket Roads to the main ship channel South of Boston Light, and is termed the *Back* or *Western Way*.

Vessels waiting for a pilot may anchor in the main ship channel anywhere between the lighthouse and Nantasket Beach.

To vessels outward bound from Boston Lighthouse, who would wish to fall in with Cape Cod, the course is S.E. by E. ½ E., distant 11 leagues, thence 3 leagues to the lighthouse; and when it bears S.W., 2 leagues distant, you may then steer S.S.E., which will carry you out of the South Channel.

Vessels in Boston Bay, which bear away for Cape Cod Harbour, must endeavour to fall in with Race Point Lighthouse, which shows a flashing light, and run for it till within half a mile; when it bears E.N.E. haul up E.S.E., or as near as the wind will permit, and anchor in from 10 to 4 fathoms, in

Herring Cove, where there is good shelter with the wind from N.N.E. to S.E. by E. Should the wind shift to the N.W., Provincetown Harbour is under the lee to which we refer; should you first make Cape Cod Light, bring it to bear E. by N., and run for it until you have soundings in 14 or 15 fathoms; then steer N.E. until the light bears E. by S.; then run in N.W. for the harbour.

Between Cape Ann and Cape Cod there are from 50 to 17 fathoms; the latter 4½ miles N. by E. from the Race light, with 55 fathoms inside. S.E. by E. ¼ E. from Boston light to the Race light there is a ridge of rocks and sand of 7 to 23 fathoms water, with a small gully of 37 fathoms, 20 miles from Boston light. To the North of this ridge the bottom is generally muddy, and the depth from 40 to 50 fathoms.

It is high water, full and change, off Race Point, at $10^h\ 45^m$. Vessels leaving Cape Cod, bound to Boston, should calculate the tide, as the flood sets strongly to the S.W. off Cape Cod, from the Race to Chatham; flood sets to the South, ebb to the North; southern tide 9 hours, northern tide 3 hours.

Boston City, the capital of New England, and the second place, in point of commerce, in the United States, consists of three parts—Old, South, and East Boston; and its harbour is one of the best in the United States. The Eastern Railroad commences at East Boston. The Lowell Railway runs on the bridge over Charles River, and the Worcester and Providence Railroads run from the South side of the city. By means of these communications this city has become the focus of much commerce.

Nantucket Shoals.—These very dangerous shoals, lying immediately in the line of traffic of the coasting trade of the United States, have been but very little known till within a few years; and then their limits were first more exactly defined at the expense of a private individual, Mr. L. M. Blunt, of New York. These "Goodwin Sands" of the United States now, however, appear tolerably well examined, though still some doubt has been expressed as to whether their entire extent has been ascertained, by the United States Coast Survey, chiefly by Lieutenant Charles H. Davis, United States Navy. The danger of these formidable shoals is much reduced by the lighthouse on *Sankaty Head*. This tower is 65 feet high, painted in three horizontal rings, shows a flash of 10 seconds in every minute, at an elevation of 150 ft.

The *Old South Shoal* has from 6 to 18 ft. water on it, and is 2½ miles in extent. From its centre Sankaty Head bears N. ¾ W., distant 12½ miles.

From the middle of the *New*, or *Davis' South Shoal*, with 8 to 18 ft., 1½ miles in extent, the middle of the Old South Shoal bears N. by E., distant 6¾ miles. No part of Nantucket Island is visible from it in the clearest weather, but the Sankaty light may be seen.

The Lightvessel, which lies nearly 2 miles to the South of Davis' South Shoal, marks the limit of dangers in this direction. She lies in 14 fathoms, in lat. 40° 56′ 0″ N., long. 69° 51′ 50″ W. A *bell* and *fog-horn* are used in foggy weather. The shoal soundings, however, do not cease here, for a spit with 8 to 10 fathoms extends for about 7 miles farther South.

Within the Old South Shoal there are many dangerous patches, which can be best described in the chart, but to the eastward of Nantucket Island, in 1849, six shoals, of small extent, but not the less dangerous, having from

9 to 14 ft. were discovered, and placed by Lieutenant-Comm. M'Blair to the northward of these. They lie generally about *E. by S.* from the Great Point Light of Nantucket Island, at distances varying from 13 to 15 miles off. They are sharp, abrupt ridges of fine white sand, which are readily discovered by the rip of the tides at all times, except at slack water, but by daylight they exhibit the usual discoloration.

To the southward of M'Blair Shoals, a line of breakers and shoal patches, called the *Great Rip*, extends to lat. 41° 2′. To the East of the southernmost of these patches, with 9 ft. water, a buoy-boat is moored. At 2½ miles East of this is another long shoal, *Davis' Bank*, on which there are only 3¾, 4, and 5 fathoms for 5 miles. From the N.E. end of Davis' Bank shoal patches of from 2¾ to 10 fathoms extend 10 miles to the south-westward and join the East end of the outermost shoal known as the *Fishing Rip*, a line of shoal patches, with 4 to 9 fathoms on it, between 41° and 41° 10′.

It would seem as if this labyrinth of shoals would scarcely ever be known, for in 1860 the *Asia* discovered a line of 10-fathom patches 15 miles S.S.E. of the tail of the Fishing Rip, where the water was supposed to be deep.

The main body of the flood tide runs to the eastward, the ebb to the westward. The currents always run across the line of directions of the shoals, and are much more rapid during their passage. This makes a near approach particularly dangerous on the side toward which the tidal current is setting.

The current is never still. During what is called slack water, the velocity is rarely less than half, sometimes more than 1 mile. A careful attention to currents is important in this vicinity.

It is high water, full and change, at XII^{h} 4^{m}; mean rise and fall 3 feet 2 inches.

From the South Shoal Lightship to *Montauk Point Lighthouse*, at the East point of Long Island, the bearing and distance are W. by N. ½ N. 91 miles. From Montauk Point the South coast of Long Island trends W. by S. ½ S. for 33 miles, to Shinnecock Bay, in the rear of which is a high lighthouse, 150 ft. high, showing a fixed light. From hence to the Fire Island inlet, at which there is another high lighthouse, with revolving light, is W. by S. ¼ S. 34 miles, and from hence to Sandy Hook is W. ¾ S. 37 miles.

NEW YORK.—The lighthouses and lightvessel which indicate the entrance to New York Harbour, are described in the table. The chart of the approaches is the best guide, both for the depth and quality of bottom,* and Lieutenant Murray has founded an elaborate description on its indications which cannot be quoted here. The water shoalens gradually towards Long Island, but is deepest at the East end, where 20 fathoms is found at 9 miles off, while at its West end this depth is only to be got at 25 miles off. This circumstance is a good guide. There is another singular feature which may mislead if not known. There are about seven deep holes lying in a south-east direction from Sandy Hook, which have from 10 to 15 fathoms more

* See plan on the chart of the Coasts of the United States published by the proprietor of this work. Fuller directions are given in the Book of Directions which accompanies that chart.

water than immediately around them; but the outermost is in lat. 39° 37′ N., long. 72° 25′, and has 145 fathoms, nearly 100 fathoms more than surrounds it, and 15 miles within the 100 fathom line. The others are known as the 38, 37, 37, 32, 21, and 23 fathom holes. This range of holes with the light-vessel at one end, and the 38 fathom hole at the other, is 55 miles long and 11 miles broad, at the outer end, and 2 miles at the inner end. This will, by careful attention, afford a good guide.

When Block Island bears N., distant 4 or 5 leagues, you cannot see any land to the northward or eastward; but as you approach the island, you see Montauk Point to the westward, making a low point to the eastward, on which is a lighthouse. In sailing W.S.W., you will make no remarkable land on Long Island, from the eastward of the said island to the westward, its broken land appearing at a distance like islands; but may discover Fire Island lighthouse, which shows a revolving light. From Fire Island light a shoal extends South three-fourths of a mile, on which the flood tide sets very strong. It is not safe to approach the shore nearer than 2 miles when the light bears to the E. of N. To the eastward of the light the shore is bold. When Fire Island light bears North in 10 fathoms water, you may steer W. by S., which will carry you up with Sandy Hook light. The quality of the bottom is various, viz., yellow, red, brown, blue, and gray sand, within short distances. About South from Fire Island, 33 miles distant, and 40 miles S.E. by E. from the Highlands, lies a bank extending from N.E. by E. to S.W. by W., having on it from 10 to 14 fathoms, pebbles. Within this a short distance, you will get 20 fathoms, when it shoals into 16 fathoms, gray sand, which depth you will carry till you get into what is called the Mud Hole, where are from 20 to 36 fathoms water, marl or green oaze, and sometimes pebbles, the deepest part of which bears East from the northernmost part of the Woodland, 10 miles; and S.E. ½ S., 15 miles from Sandy Hook light. From the Mud Hole to the bar of Sandy Hook the water shoals gradually, as laid down on the chart.

You will have 20 or 22 fathoms water out of sight of the land, sandy bottom in some, and clay in other places. Before you come in sight of sandy Hook lighthouse, you see the Highlands of Navesink, with its lighthouses, which lie W.S.W. from Sandy Hook, and is the most remarkable land on that shore.

If you fall in to the southward, and make Cape May, it would be prudent to keep about 3 leagues off, to avoid Five Fathom Bank, which lies from 5 to 6 leagues eastward from the cape, and is marked by Cape May lightvessel to the eastward. Hereford Inlet, 10 miles north-eastward of Cape May, is frequented by the Delaware pilots, having no other harbour to the northward until they reach Egg Harbour. After passing Cape May lightvessel you may steer N.E. when in 10 fathoms water, taking care that the flood tide, which sets very strong into the inlet, does not draw you too close; this course continued will carry you up with Egg Harbour; you will then have fine white and black sand, intermixed with small broken shells; by continuing the same course, you will deepen your water, and so continue till you draw near Barnegat Inlet. In running along the shore, do not steer to the northward of N.E., if in 10 fathoms water or less, as you will be apt

to get on Absecom Shoals, or Egg Harbour Bar. Off Barnegat Inlet you will get bright coarse yellow gravel. The shoal off Barnegat does not extend beyond 2 miles from the beach, and is steep-to; you may turn this shoal in 6 fathoms water, within pistol-shot of the outer breaker. It would always be prudent to keep in 9 or 10 fathoms water during the night, and not steer to the North of N.E., unless certain of being to the North of the shoal.

The soundings are so much to be depended on, that the moment you lose the above soundings you are past the shoal, when you will have fine black and white sand, and very hard bottom; you may then haul in for the land N. by E., which course will bring you along shore in from 15 to 17 fathoms water, but if the wind and weather permit, I would recommend hauling in N.N.W., which will bring you in with the southernmost part of the Woodlands, which is very remarkable, having no other such land in the distance from Cape May up to the Highlands, and can be distinguished by its being very near the beach, and extending to Long Branch.

In passing from Barnegat to Sandy Hook, when to the southward of the lights on the Highlands, you must not open the northern light to the westward of the southern light, as that will bring you too near the Jersey shore.

As a number of vessels have been lost, bound into New York, from heaving-to with their head on shore, we cannot too strongly urge on the shipmaster the necessity, *if he is in doubt of his position, of heaving-to with the head off shore.*

Directions for proceeding onwards into New York Bay must be left for more extended works and to the assistance of pilots.

Sandy Hook to the Delaware.—To the valley at the foot of the Highlands of Navesink succeeds a tract of low table land, and southward of this is a considerable and remarkable tract of Woodland, which terminates at 6 leagues S. by W. from the Navesink lighthouses; next follows an extensive lagoon, named Barnegat Sound, which is fronted by a narrow strip of low land. The coast from the highlands of Navesink to the elbow of an island, called *Barnegat Long Beach*, trends nearly *S. by W. ½ W.* 38 miles, and the soundings regularly decrease toward shore from 12 to 7 and 5 fathoms.

In the parallel of 39° 47′ is the *Inlet of Barnegat*, or the entrance of Barnegat Sound. On the South side of it is a red and white lighthouse, 160 ft. high, with a *revolving light*. A shoal bar extends outward from this place to the distance of 2 miles, and the bottom is an admixture of mud, shells, and gravel. The outer edge of the shoal is steep-to, and you may pass it in 6 fathoms within a short distance from the outer breaker; but, during night, keep at least in 9 or 13 fathoms. The soundings more to the northward in these depths are fine white sand, with very hard bottom.

Barnegat may be readily known in the day, even when the breakers are not seen, as there is a long grove of wood, back in the country, apparently 3 or 4 miles long, directly within the inlet, and commonly called the *Little Swamp*. With the North end of this land directly abreast, you will be to the northward of Barnegat.

Between the elbow of Barnegat Long Beach and Cape May, at the mouth of the Delaware, the coast forms a gentle concavity, but its general trend is nearly S.W. ½ S. and the distance 18 leagues. The land is generally low

and broken, forming several islets and inlets. The soundings are regular, commonly 8 to 10 fathoms at 2 leagues from shore; but there is a sand bar at every inlet, several of which extend off to a considerable distance.

Little Egg Harbour, in the parallel of 39° 28′, long. 74° 19′, is a small harbour formed by low isles or beaches on the East, and by salt marshes on the West. It is known as the port of *Tuckerton*. To a stranger this harbour cannot be recommended, unless as a retreat in case of emergency, several shoals about the entrance being dangerous; yet it has frequently served as a place of shelter in the winter, when violent N.W. winds have prevented vessels from entering the Delaware or New York Harbour. The lighthouse which is white, stands on the South side of the entrance, and shows a fixed and flashing light.

Absecum Inlet, at the distance of 6 miles S.W. from Little Egg Harbour, is another harbour which affords shelter to vessels of easy draught. A lofty tower, 150 ft. high, on the South side, shows a *bright fixed light*.

The shoal water extends at least 2 miles off shore at Absecum Inlet, and at 2¼ miles E.S.E. of the lighthouse is a 3-fathom shoal. The *Round Shoal*, with 11 ft. water, lies S.E. ¼ E. 1⅔ mile from the lighthouse.

In sailing between New York and the Capes, if the wind should be in the N.W. quarter, with which, in general, is clear weather, keep no further off than to 10 fathoms; the nearer in-shore the stronger the current, which sets about one mile in an hour. The tide of flood runs W. by S., and the ebb E. by N., but you will have no tide till further off than in 8 or 9 fathoms.

If you are turning, with the wind to the westward, stand off no further than to 18 or 20 fathoms of water. You may venture to stand in-shore into 6 fathoms, until you advance towards Hereford Creek, or about 2 leagues to the northward of Cape May.

The greatest danger to a ship cruising hereabout is the shoal called the *Five Fathom*, or *Cape May Bank*, and lying at the distance of 4 or 5 leagues East to E.S.E. from Cape May. Much of the danger is averted by the lightvessel, showing fixed lights, which is moored in 12 fathoms outside of it. She carries a *steam fog-whistle*.

DELAWARE BAY.—Cape May and Cape Henlopen, the two extremities of the estuary called the *Delaware River*, bear from each other S.W. by S. and N.E. by N., 10 miles distant. Each is distinguished by lights at night. A great tract of overfalls and broken ground, southward of Cape May, is 2 leagues in extent; the depths over them are from 5 to 15 ft. These shoals form the two channels into the river, of which the chief, between the shoals and Cape Henlopen, is nearly 5 miles in breadth.

Cape May Lighthouse is on the extreme S.W. point of the cape. It shows a *revolving light*, and bears N.E. by N. about 11 miles from Cape Henlopen light.

Cape Henlopen Lighthouse is of an octagonal form, handsomely built of stone, 82 ft. high; the light is *fixed*, and may be seen at 20 miles off, if the weather be clear. At the distance of three-quarters of a mile from the Cape Henlopen high light, and near the sea, is a *fixed* beacon light, of small power, 45 ft high. The two lights in range is the leading mark for carrying vessels into the Roads, within the cape.

The steam *Fog-trumpet* on Cape Henlopen gives a 6-second blast in every three-quarters of a minute.

To enter the Channel by Cape Henlopen, the course in the fairway between Cape May and the lightvessel, which has been described, is S.W. until the lighthouse on Cape Henlopen bears West. Then steer for it in the latter direction, and within 2 miles from it you will have 14 or 15 fathoms of water; having passed it, you may steer W.N.W. until you bring it to bear E.S.E., when you may anchor in *Oldkiln Road*, in 3 or 4 fathoms.

The Beacon Light on Cape Henlopen, already noticed, exhibits a brilliant light, that can be seen at 3 leagues off. It stands on the extreme North end of the cape, very near the beach, three-quarters of a mile from the high light. Vessels running in for Oldkiln Roads, may, when the beacon light and high light are in one, bearing N. $\frac{3}{4}$ W., approach the former within a cable's length, then steer W.N.W. until the high light bears S.E., and anchor in 4 fathoms, good holding ground.

The estuary of the Delaware for 70 miles from the sea had no safe natural harbour, and to remedy this defect the General Government of the United States constructed a *breakwater* within Cape Henlopen, forming a safe harbour. On the N.W. end of the breakwater there is a lighthouse, showing a flashing light.

In approaching from sea, and going in by the South passage, give the beacon light on the pitch of the cape a berth of from 400 to 500 yards, and when you bring the West end of the breakwater to bear N.W., steer for it, and anchor in a line between it and the government house on the beach, as close to the works as you can with safety; the light on the West end bearing about N. or N. by W. There is no difficulty, with common attention, in running into the anchorage to the South of the breakwater, even in a gale of wind, either between the two works, or by the passage to the S.E. of both.

A course of S.S.E. $\frac{1}{2}$ E., 23 miles from off Cape Henlopen, will clear the Cap, and lead well to the eastward of the Fenwick Shoal, and when you get the bell-boat, riding off that shoal, to bear about West, you may alter your course to S.S.W. This course for about 30 miles will bring your nearly abreast of Winter Quarter Shoal, about the parallel of 38°; then a long course of 60 miles S.W. by S., if your vessel will lie well up, will bring you abreast of Smith's Island Shoal, with Smith's Island light bearing W. by N.; from hence a S.W. by W. course for 18 miles will take you to Cape Henry.

In pursuing the course of the land from Cape Henlopen southward, you will see an opening at the distance of 11 miles; this is *Indian River Inlet*, fit only for vessels drawing not more than 6 ft. water.

In proceeding along these coasts during easterly winds, great caution is requisite; as with such winds the weather is generally hazy, and the coast obscured. The current will generally be found setting to the S.S.W., in the direction of the shore.

The *Coast of Delaware*, South of Cape Henlopen, is nearly a straight line running due *South, true*, for 11 miles, to Indian River Inlet, and 10 miles further to the boundary between Delaware and Maryland. It is very low,

broken into long narrow islands, with off-lying shoals to the distance of 1 to 1½ mile.

Fenwick Island Lighthouse, which stands on the state boundary, shows a bright fixed and flashing light, from a white brick tower.

South of the parallel of 38° the shores appear in numerous islets, swamps and inlets, and so it continues to Cape Charles, at the mouth of the Chesapeake. In all this extent the only distinguishing marks useful to a stranger are the lighthouses of Assateague, Hog Island, and Cape Charles lighthouse, on Smith's Island. These are fully described in the table.

Matomkin and *Machi-Pongo* are very dangerous harbours in a gale of wind; but you may ride along shore with the wind from N.W. to S.W. When the wind blows hard at N.E. or E.N.E., and you are in sight of Chincoteague Shoals, your only chance for safety is to stand to the southward, for you cannot clear the land to the northward.

The *Coast of Maryland*, as far as Chincoteague Inlet, in lat. 37° 54′, is still a low, straight coast, curving towards the West, and off it are some *dangerous shoals*.

Fenwick's Island Shoal.—The centre of this shoal is in lat. 38° 27′ 30″ N., long. 74° 56′ 9″ W. It is about 2 miles long, running from S.W. to N.E. The least water on it is 15 ft. It bears S.E. by S., distant 11 miles from Indian River Inlet, and E. ½ N. from Fenwick's Island lighthouse. On the seaward side the soundings change suddenly from 10 to 2½ fathoms, and there are 19 fathoms about 2 miles West of this shoal, which appears to be extending on the West side and towards the North. An iron bell-boat marks its N.E. side. Between it and the shore are several 3½-fathoms patches.

Isle of Wight Shoal, on which there are but 3 fathoms water, lies 4 miles S. ½ E. from the centre of Fenwick's Island Shoal. It is nearly 6½ miles East of the beach, and bears East from Isle of Wight woods. There are 10 fathoms water within a mile on either side of this shoal.

Midway between these two shoals there is a spot with 3½ fathoms water on it.

At 9 and 11 miles South of the lighthouse are two shoals, *Little and Great Gull Banks*, with 12 and 18 ft. water over them, lying 2 and 5 miles off shore. South of the latter 10 miles, and 8 miles off shore, is a small patch of 21 ft. At 30 miles southward of Fenwick's lighthouse is Winter Quarter Shoal.

Winter Quarter Shoal is 1½ mile long, and one-third of a mile wide, running in a direction E. by N. ¾ N. and W. by S. ¾ S. (E.N.E. and W.S.W.) with not over 3½ fathoms water upon it. The least water is 12 ft. in several places at low tide. On the seaward side the soundings change suddenly from 9 to 4, and then to 2 fathoms. It is 6½ miles distant from the nearest land, with 10 fathoms water between it and the shore. In clear weather the lantern of Assateague lighthouse is just visible from it. The centre of the shoal bears from Assateague light E. by N. (E. by N. ¾ N.) distant 11½ miles.

At 3 miles E. by S. from it is a patch of 3 fathoms, and between it and the Gull Banks are several spots of 3½ to 5 fathoms, which will be best understood by referring to the chart.

A Lightvessel is moored in 11 fathoms water, S.E. by E. ½ E., 2 miles from the centre of Winter Quarter Shoal. She is painted red, carries two masts, and shows a *fixed bright light* at an elevation of 15 ft. above the level of the sea.

Black Fish Banks form a long narrow bank or ridge, running in a direction N.E. ½ E. and SW. ½ W., 4¾ miles long, and distant from 4½ to 6 miles from the shore, with from 3¼ to 5 fathoms water upon it. The North end bears E. by S. ¼ S., distant 7¼ miles, and its South end S.E. by S., distant 5¾ miles from Assateague lighthouse.

Chincoteague Shoals are the outer shoals off Assateague lighthouse, and bearing from it from S. ¼ W. (South) to S.E. by E. (E.S.E.) comprising six points of the compass, and at a distance from it of from 3¾ to 4¼ miles. They have from 9 to 17 ft. water upon them.

Within a semi-circle of 15 miles from Assateague lighthouse the bottom is very uneven and broken. The general direction of the current is to the southward and westward.

The **CHESAPEAKE**, one of the finest estuaries on the globe, being 163 miles in extent from North to South, is the recipient of many important rivers, which fall into it on all sides, but especially on the North and West. At its head is the *Susquehanna*, which pervades Pennsylvania; on the N.W. the *Patapsco*, falling from Baltimore; at a degree further South is the *Patuxent*; then the *Potomac*, which passes the City of Washington; the *Rappahanock*, running downward from Fredericsburg; *York River*, on which are situated York Town and Gloucester; *James River*, on which stands the City of Richmond; and, in the South, *Elizabeth River*, the harbours of Norfolk, &c.

Its entrance lies between Cape Charles on the North and Cape Henry on the South, being about 10 miles in width, but owing, as it appears, to the southward drift, the northern side of the entrance, like the Delaware, is embarrassed by shoals.

Cape Charles Lighthouse, which stands on Smith Island, or above 4 miles eastward of Cape Charles itself, marks the northern side. It is 150 feet high, and shows a fixed light, varied by a bright flash every 45 seconds, visible 19 miles off.

Cape Henry Lighthouse marks the southern entrance, and shows a *fixed light*, elevated 129 ft.

A lightvessel on the tail of the Horse-shoe Shoal lies immediately in front of the entrance of the Main Channel. She has a fog-bell and horn, and lies with Cape Henry light, bearing S.E. by S. ¼ S.

Ships falling in with the land to the northward of the entrance should not stand inwards to a less depth than 7 fathoms. In coming along shore from the southward, 7 fathoms will be a proper depth to keep in, until up with Cape Henry; whence falling into 8 or 9 fathoms, with a stiff or sticky bottom, you will be in the channel way.

When you come in towards the land, to the southward of Cape Henry, you will have deeper water than when you are in the latitude thereof; as 21 fathoms, reddish sand, and pretty large; 9 leagues off it there are 35 and 40 fathoms, fine gray sand.

The land is low and sandy; you cannot see it above 7 leagues off. Cape

Henry is low, but bluff, with a few trees to the seaside, and at a little distance from the water, It is moderately steep-to, excepting that a small shoal stretches out 2 cables' lengths from the shore East of the lighthouse, and there is nothing to hinder a ship from passing into Lynnhaven Bay, where there is soft ground, and from 4 to 6 fathoms of water. The bank, called the Middle Ground, is about 4 miles from the cape.

When coming from sea, in the latitude of Cape Henry, 36° 56′, you will meet with soundings, as above described. You may readily ascertain when in soundings by the muddy colour of the water. In clear weather the land of Cape Henry may be seen from the depth of 10 or 11 fathoms, regular soundings, which extend 5 or 6 leagues to the southward of the cape; more to the northward the soundings are irregular and coarser, as above described.

In coming in for the Chesapeake, you may advance to Cape Henry, but cautiously avoiding the *Middle Ground*, which occupies so large a portion of the entrance, and which may be still increasing. With a northerly wind you may approach this bank to the depth of 5 fathoms. To the southward of it you find 12 and 13 fathoms, as well as in the channel between it and Cape Henry. This channel has a depth of 8 fathoms close to the cape.

With a fair wind you may run in with the lighthouse bearing W. by N.; and, with a turning wind, you may stand to the southward until it bears N.W. by N., and to the northward until it bears West.

If requisite, you may run in with the lighthouse bearing West, as this course will lead to the channel way, in from 7 to 10 fathoms, sticky bottom, as before mentioned. It is then proper to take soundings towards the southern shore; and, in order to do this, steer West, until you have advanced to a short distance from the lighthouse; then, rounding the point, you may haul into *Lynn Haven Roads*, and anchor in from 7 to 4 fathoms.

From Cape Henry, in lat. 36° 55′, to Cape Hatteras, in 35° 15′, the coast forms a concavity in the greater part of its length, to the lat. of 35° 40′, trending nearly S.S.E.; and the rest inclines a little to the westward of South to the extremity of the cape, in long. 75° 30′ W. It is all low and bordered with narrow islets, at the back of which are *Currituck Sound*, *Albemarle Sound*, *Pamplico Sound*, &c. The lighthouses established on Currituck Beach and Bodies Island, at the North side of Oregon Inlet, are described in the Table. Bodies Island is S. by E. ⅓ E., 70 miles from Cape Henry light.

The *Wimble Shoals* lie between the latitudes of 35° 30′ and 35° 34′. They extend 2 leagues out from the shore, but there is a passage between them and the land. The sea always breaks over them in a gale.

To the southward of the Wimble Shoals there is a large mussel-bank, intermixed with cockles and small pebbles, having 5, 4½, and 4 fathoms of water; its outer ledge is about 4 miles from land, and there is a depth of 9 fathoms between it and the shore.

Cape Hatteras, although not conspicuous for its elevation, being only a low sandy spit, gradually extending to the southward, is very remarkable as being a turning point in the coast of the United States. The shores on either side are purely diluvial, formed and extended by the action of the currents which drift past them. Lying upon the line of junction between

the two wind and current systems, where the East and West tendencies divide, we here meet the first evidence of the conflict between them in the singular line of shoals which project at right angles to the line of coast—an evidence of the conflict between the Gulf Stream and the southerly current coming from high northern latitudes.

The Lighthouse on Cape Hatteras, painted red and white, stands 2 miles North of the point it was built to indicate. It shows a *bright flashing light* every 10 seconds, at 185 ft. Near the extremity of the point a fixed beacon light is shown, which bears S. ¼ W. from the high light.

The Hatteras Shoals are most dangerous. The outer shoals, 3¼ miles in extent, have from 9 to 15 ft. water. Between them and the *Diamond Shoals* is a 6-fathom channel, 2½ miles wide. These shoals have 12 ft. least water. A spit runs off for 1½ mile S.S.E. of the beacon light.

A *Whistle Buoy* (automatic, see *note*, page 763) is placed in 12 fathoms water about 2¾ miles south-eastward of the outer shoals, with Cape Hatteras lighthouse bearing N.W. by N. 11½ miles distant.

To clear the *Outer Shoals*, in approaching them from the northward and eastward, bring the lighthouse to bear West in 12 to 10 fathoms water, when run South, keeping in not less than 10 fathoms water, until the lighthouse bears N.W. ½ N., when any course South of West may be steered with safety.

In coming from the southward and westward, keep in not less than 10 fathoms water, until the lighthouse bears N.W., when any course eastward of North may be steered. The beacon light and the high light in one clears all to westward.

In bad weather, and especially at night, do not approach the Outer Shoals nearer than 15 fathoms water from the northward and eastward, and 12 to 11 fathoms from the southward and westward.

It is necessary to watch the bearings of the lighthouse, and keep the lead going in beating round or between the shoals. In approaching the shoals at night, or in bad weather, if the lights have not been seen before night, it will not be prudent to run in for it.

As 10 or 11 fathoms water may be found to the westward of the shoals, in going outside of them from the southward and westward do not approach the land to the southward of the cape nearer than 8½ to 10 miles.

Between Cape Hatteras and Cape Lookout, the next projecting point, a long sweep of narrow banks which separate the ocean from *Pamplico Sound*, extend in a curve for 64 miles.

The narrow beachy isles which form the coast between the two capes, form an inlet into Pamplico Sound, named *Ocracoke Inlet*, the shoal bar of which (extending 2 miles seaward) is 9 leagues S.W. by W. ½ W. from the lighthouse on Cape Hatteras, and 13 leagues N.E. ¾ E. from Cape Lookout. On the eastern side of the inlet is a *lighthouse*, exhibiting a *fixed light*, which bears from the middle of the bar, in 13 ft. water, N. ½ E. 3¼ miles, whence the course in is N.W. by N. ½ N.

The soundings all along, between the shoals extending from the two capes, are regular, gradually diminishing from 14 and 15 fathoms to 5 and 6 fathoms near shore, all sandy ground.

CAPE LOOKOUT is marked by a red tower 150 ft. high, showing a fixed light. It stands 2½ miles N.N.E. of the point of the cape.

The light may be seen from the outer end of Cape Lookout Shoals; but vessels passing are recommended rather to trust to the lead than to making the light.

From Cape Lookout the shoals extend, nearly in a S.S.E. direction, to the distance of 3 leagues from the lighthouse. The broken ground extends to latitude 34° 28′; in this parallel are 10 fathoms of water, and thence to the edge of the Gulf Stream the soundings gradually increase to 25 fathoms. From Cape Hatteras lighthouse the outer part of Cape Lookout Shoals bears S.W. 22½ leagues; and from the outer part of Cape Hatteras Shoals S.W. ¾ W. at the same distance.

A shoal, having only 14 ft. water on it, lies S. by E. ½ E., distant 10½ miles from Cape Lookout lighthouse, and about 2¼ miles to the southward of the extreme South point of the 3-fathom edge of the shoal that extends 7 miles to the South of Cape Lookout.

A *Whistle Buoy* (see *note*, page 763) is moored south-eastward of Cape Lookout Shoals in 11 fathoms water, with Cape Lookout lighthouse bearing N. by W., distant 17 miles. Lat. 34° 20′ N., long. 76° 26′ W.

From the lighthouse the coast trends to the northward of West, but the low spit stretches out, as above said, for 2½ miles to the S.S.E. of this direction.

Beaufort Harbour is about 8¼ miles N.W. from the South spit of Cape Lookout, and affords shelter from all winds, and is easy of access, carrying 17 ft. over the bar at low water. It can be entered with all winds except between N. and W.

CAPE FEAR is the south-western extremity of another of those long beaches which characterise this portion of the American coast. Its extremity bears S.W. by W. ½ W. from the spit of Cape Lookout, distant 84 miles, but the shore recedes 18 miles from the direct line.

The low sandy point known by the name of *Cape Fear*, is the S.E. extremity of a marshy island called *Smith's Island*, which forms the two entrances of Cape Fear River and the Port of Wilmington.

Federal Point Lighthouse, upon the North side of the *New Inlet*, at 3 leagues North from the extremity of the cape, is a white tower, showing a fixed light, visible 12 miles off.

The Frying Pan Shoals, a very remarkable line of reefs, run in a S.S.E. direction 16 miles from Cape Fear. They are not more than half a mile in breadth, and at their outer end there is a *lightvessel*, showing two lights.

In passing Frying Pan Shoals, *sailing vessels of heavy draft* should keep in from 15 to 18 fathoms, especially in threatening weather, and under no circumstance run into less than 10 fathoms. Steamers in good weather may cross the outer end of the shoals in 10 fathoms. The *lightvessel* marks their outer end, as above said.

There are two shoal spots with 16 to 18 ft. water on them bearing S.S.E. ½ E. to S.E. by S., distant 16 to 17½ miles from Bald Head, the western cape of Smith Island.

From Cape Fear the coast again forms a sweep of curved beach, called the

Long Bay, and at 81½ miles S.W. ½ W. from its extremity is Cape Roman, or *Romain*, Lighthouse.

CAPE ROMAN is very improperly so called, it being a very low land, without either tree or bush, and appears at a distance like a sand left dry by the tide. To the W.S.W., about 2 miles from this cape, on the isle called the *Great Raccoon Kay*, there is a red brick lighthouse, 150 ft. high, which exhibits a bright revolving light every minute, visible 23 miles off. The old tower, which stands near, is painted in horizontal stripes, alternately red and white. With the light bearing from N.W. by N. to N.E. by N. there is good anchorage on the flats, in 3 fathoms, to the East of the mouth of the inlet called *Bull's Bay*.

Cape Roman Shoals extend for 5¼ miles E.S.E. from the lighthouse, or 3½ miles from the South spit of the Cape Island. A *striped nun buoy* was formerly moored in the Slue Channel, to be passed on either side.

Vessels of heavy draft should not approach Cape Roman within 8 fathoms water, there being a 5-fathom bank outside of the shoals.

Vessels of light draft coming from the southward, and intending to run inside the shoals, will, when in 4¾ fathoms water, bring Cape Roman Old Lighthouse and the old mill in range, the South point of Cape Island bearing N. by E., then steer N.E., passing directly through the slue.

These shoals are of a dangerous character, lying directly in the track of coasters, 6 miles distant from the lighthouse; they are about 1 mile in extent, and have but 6 ft. water upon them, and shoal very rapidly from 6 fathoms to 3 ft. With moderate winds from N.E. or West, the sea does not break upon them, but with winds from S.W. around by South to the East, they are shown by the breakers on the seaward side.

Inside the shoals there is a good 15 ft. channel, nearly 2 miles in width, and a 6 ft. channel extends from the S.W., leading to the harbour inside the cape. There is good anchorage during northerly winds S.W. of the lighthouse, with not less than 3 fathoms water.

A lighthouse, which marks the entrance of Charleston Harbour, bears S.W. ½ W. 35 miles from that of Cape Roman. The land between is alluvial, and forms numerous low islands—an extension of the famous Sea Islands—the principal of which are named Bull's, Capers, Devies, Long, and Sullivan's Islands. Flats extend from all these isles, along which the soundings ar regular. Bull's Island appears very bluff, with red sand-hills, and a spit from the outer end of it extends eastward, about 5½ miles. On it is a brick light-tower, 35 ft. high.

A spit called the *Rattlesnake* also extends to the distance of 5 miles E. by S. from Sullivan's Island, which forms the North side of the entrance to Charleston, and you will be on the edge of it in 5½ fathoms. Its outer extremity is marked by the *lightvessel* in 6 fathoms, and showing two lights.

When Charleston churches are seen to the northward of Sullivan's Island, you will be on the edge of the Rattlesnake; and when the churches are open to the southward of Sullivan's Island, you are clear of that shoal, or Fort Moultrie bearing W. ¾ N. clears them to the southward. You should approach no nearer to this bank than in 5 fathoms of water.

CHARLESTON is the principal seaport and town of South Carolina. It is on a low tongue of land at the confluence of the Wando, Cooper, and

Ashley Rivers,* about 6 miles up the harbour, which is entered between Sullivan's Island on the North, and Morris Island on the South, the opening between them being 1⅓ mile wide. The banks, across which are the entrance channels, are 3 miles broad outside the line of coast. Nearly in the middle of the entrance is the famous Fort Sumter.

Operations are now being carried on for the improvement of Charleston Harbour. Mons. Maillefert, the engineer, who began the work in 1872, had at the end of 1874 removed twenty-three vessels, sunk during the American war, all of which impeded the navigation.

Charleston Main Light, on the South end of Morris Island, is a handsome tower, 150 ft. high, painted in black and white bands. From it is shown a *fixed bright light*, elevated 152 ft. above the sea, and visible 18 miles off.

On the South end of *Morris Island*, at nearly half a mile southward of the Main Light, stand two range beacons, the front one being a pyramidal wooden tower, 15 ft. high, painted red; the rear one, a black framework, 35 ft. high. From these, *two red lights* are shown, at 20 ft. elevation, from the front beacon, and 40 ft. from the rear. Kept in line W. by N. ½ N., they lead through the Pumpkin Hill Channel until Sullivan Island lights are in line.

On *Sullivan Island two fixed red lights* are shown, the rear light elevated 57 ft., and the front light 34 ft. They show in full brilliancy down the Main Ship Channel, from S. by E. to S. The beacons from which these lights are shown are coloured white, the front one situated on the N.E. angle of Fort Moultrie, and the rear beacon 600 yards to the northward.

At *Fort Sumter*, on the opposite side of the channel, and W.S.W. of Fort Moultrie, a *fixed light* is shown from a brown wooden frame on the N.W. face of the fort, elevated 57 ft., visible 12 miles off.

At *Castle Pinckney*, a *red* light is shown from a yellow tower, elevated 41 ft.

Buoys.—Red buoys mark the starboard side of the channels entering, and black the port. Black and red in horizontal stripes are danger buoys. Black and white vertical striped are channel buoys.

The Channels are constantly shifting. In the survey, published by the U.S. Hydrographic Office, in 1871, four channels are shown as leading into the Main Channel from the eastward. The northernmost of these is called the *Beach Channel*, which passes close along the South side of Sullivan's Island. By the recent removal of Bowman's Jetty, formerly extending from Sullivan's Island into the channel, there is now a depth of 17 ft. through. From the buoy at its eastern end the distance is 1½ mile to its junction with the Main Ship Channel off Fort Moultrie, the narrowest part, where the channel is not a cable wide. Two buoys mark its eastern end.

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* In a letter addressed to the Board of Trade, and published in the "Mercantile Marine Magazine," December, 1870, pages 367-8, shipmasters are warned against going up these rivers for the phosphate rock, and especially against spending a night there, from June 1st to the end of November, because of the danger of an almost certain attack of malarial fever.

Swash Channel.—The outer buoy of the Swash Channel is 2 miles S.S.W. from the outer buoy of Beach Channel. It has a least depth of 12½ ft. at its western end, and is marked by a striped mid-channel buoy at its eastern end. After passing this buoy, with Fort Sumter bearing about W.N.W., you leave first a black buoy close on the port hand, and then two red buoys on your starboard hand; the last of them is on the eastern side of the Main Ship Channel.

Pumpkin Hill Channel.—The principal entrance lies 3½ miles southward of the Swash Channel. It is to be kept dredged to a depth of 20 ft. Early in 1875, Mons. Maillefert reported that a depth of 18 ft. already existed, the operations only having been begun in October, 1874.

To enter by this channel, get the lights on Morris Island, before described, in range when you are in 5 fathoms water, and steer for them, passing sea buoy (black and white perpendicular stripes) and outer bar buoy (black and white perpendicular stripes) on either hand, and leaving middle buoy (No. 1 black) and inner or junction buoy (black and white perpendicular stripes) on the port hand, soon after passing which the beacon lighthouses on Sullivan Island are in line N. ¼ W.; with these in line, proceed through the *Main Ship Channel* until Fort Sumter beacon bears West, when a N.W. ½ W. course will lead into Rebellion Road; and a W. ½ N. course will lead through the South channel, keeping the buoys that mark the South side of the shoals off Fort Ripley on the starboard hand, when Castle Pinckney bears N.N.E. steer for the wharves.

Another channel, with 13 ft. least water, lies S.W. 1 mile from Pumpkin Hill Channel. The leading mark in is with the front Morris Island beacon bearing N.W. ¼ N.

Good holding ground in 5 fathoms, at mean low water, with a soft, sticky bottom, will be found outside the bar, with the leading lighthouses on Morris Island in line.

It is high water, on full and change, at the city, at $7^h\ 24^m$. Springs rise 6 ft., neaps 5 ft.

Strong or long-continued westerly winds reduce the water on the bar from 1 to 2 ft. The flood and ebb set across the sailing line over the bar, and should be allowed for. Large vessels should cross the bar during the last quarter of flood, and *should not wait for high water.*

Complete Directions are given for Charleston Harbour in the book which accompanies the chart of the Coasts of the United States, recently published by the author of this work.

Directions for the ports of the United States South of this are given in the "Colombian Navigator," vol. i., and for the Islands and Coasts of the West Indies in vols. ii. and iii. Instructions for the navigation of the West Indies generally are given in pp. 493—516. To these the reader is referred for further information.

SECTION V.

ACCOUNT OF THE ROCKS, SHOALS, AND VIGIAS,* IN THE NORTH ATLANTIC.

The present section is in many respects a very unsatisfactory portion of our work. To deal with the conflicting and imperfect accounts which often arose of the discovery of new shoals and dangers is most perplexing. But of late these doubts have been dispelled, in most or in very many instances by the direct test of the deep sounding machine, and the testimony thus afforded as to the non-existence (at least, in the assigned position) of many of the formidable reefs described, in perfect good faith, has led many to doubt the authenticity of the whole range of reported rocks. And this disbelief is unquestionably a growing one, but the subject cannot be dismissed until a satisfactory and systematic examination of the whole bed of the ocean, now so readily done, is made.

In a subsequent section, the subject of deep sea soundings will be discussed. Its great importance in relation to the present topic, of doubtful rocks and shoals, is manifest, as it is almost the only test which is conclusive.

But while we may dismiss those dangers which have been absolutely disproved, we may also have some doubts on the correctness of some of the soundings which have been cited to show that great depths exist in their neighbourhood. In the earlier experiments which were made with small line, quite incapable of bringing back the lead, it is evident that at times the indication of them having reached the bottom by the line ceasing to run, is not altogether satisfactory.

The chief expedition which has been undertaken to disprove these numerous dangers in the North Atlantic, is that sent out by the United States Government in 1851-2, in the brig *Dolphin*, Lieut. Commander Lee, whose labours will be quoted hereafter.

It is gratifying to us to find that a former edition of this work, the "Atlantic Memoir," of 1845, was made the basis of these experiments, and we give with pleasure the disproof of many of the shoals and rocks which had been announced in this work, shown to have been given from erroneous information, or imperfect observation.

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* Vigia is a Spanish word, literally signifying Watch, or Look-out. It is generally in the charts attached to spots supposed to be dangerous, and which should, therefore, be approached with caution.

But until a perfect and systematic survey of the depth of the sea is made, we cannot pronounce absolutely that it is free from isolated dangers. The enumeration of them, therefore, will be continued for the present, not with the idea of inducing too much caution, but as a reference to show that they have not been overlooked.

An isolated rock is a very difficult matter to detect; and even the most laborious surveys have failed sometimes to detect such. Many examples might be cited of this. Thus the dangerous rock in the entrance of Milford Haven occupies what was supposed to be deep water, till accident made it known. A similar very dangerous pinnacle, the *Pin Rock*, was discovered in the entrance of Dartmouth Harbour; another, the Lee Rock, lies off the South end of Lundy Island, in the anchorage. A man-of-war was very nearly wrecked on an unknown rock in the centre of Braye Roads, Alderney, where our Government expended enormous sums in making shelter. The ship in which the Prince of Wales visited Canada struck outside a buoy in the St. Lawrence. Another rock was overlooked in the survey of Tenerife, at its East end. Several most dangerous rocks were found after the survey in the entrance of Port Phillip, South Australia. The same in the entrance to San Francisco. All these, and many others, show the difficulty of pronouncing absolutely, on the non-existence of an isolated shoal, if a pinnacle of rock may not be seen with very close search, and pass quite unnoticed in a channel way.

The accounts frequently given are very vague and ambiguous, and in some cases evidently refer to floating objects, such as trees which have in several cases been seen floating about with barnacles attached to their branches.

"It is, moreover, possible that navigators, at a certain distance, may have mistaken whales. M. de Chabert, in his voyage to America, in 1741, for the purpose of making astronomical observations, being at the distance of 70 leagues from Corvo, one of the Azores, descried a dusky body, over which hovered a number of gulls, a bird seldom seen at such a distance from land; at first he imagined it to be a rock, but on coming near, in order to observe it, he found it to be the carcase of a whale of monstrous bulk. Besides, some of these vigias may have ceased to exist, after having appeared for some time; as, for instance, the island which rose out of the sea in the year 1720, to the westward of St. Michael's, of the Azores, and which disappeared again on the 17th of November, 1723."

As a monition against too hastily forming conclusions from mere appearances, we here add, that an old friend of ours, in crossing the Atlantic, was once alarmed by the sight of breakers at no great distance. Instead of coming home with an imperfect report, he very properly sent out a boat to examine them, and found that they were caused by a floating body, thickly covered with barnacles, &c., to which a hatchet was applied, and soon disclosed a cask of wine, which proved to be excellent burgundy. It had, no doubt, been floating many years, and during the time had probably been the prolific parent of a number of *vigias*, &c. On the 4th of August, 1822, Captain Hamlin, in the brig *Recovery*, likewise picked up a hogshead of claret wine, that had been a long time in the water, and worm-eaten nearly through, lat. 34° 51′, long. 24° 51′.

We have shown in another work how easily an animated as well as a lifeless being may be mistaken for a rock. In 1818, the *Northampton*, Captain Tebbut, on her passage to India, had passed the meridian of the Cape. On the 1st of August, at noon, the ship was in lat. 40° 45′ S., and long. 24° 3′, E. On the next day an object appeared right ahead, like a boat; on nearing it looked like the wreck of a vessel, *two parts being above water*, at two ships' lengths from the lee-bow. The barnacles could be distinguished by the naked eye; but, when abeam, the creature *went down*. It proved to be a thrasher. Captain Tebbut says, "Being forward at the time we came up with the animal, the two parts above water seemed to be like a wreck, bottom upward. When I first saw the barnacles, the part covered with them looked rugged, and I was firmly of opinion that it was a rock above water; so much so, that I looked over the lee-bow to see that we were clear of it, ordering the man to starboard the helm."

A similar instance has been recorded in the "Journal of the Royal Geographical Society." "A frigate was one day running into the Rio de la Plata, with her studding sails set, when the look-out man at the mast-head reported breakers on the bow. The captain, believing that such a danger could not have escaped the notice of the Spaniards, and having also a tolerable chart of the river, suspected it must be some floating object, and ordered the ship to be steered directly for it. The officers were on the alert; glasses were frequently directed to the spot, and all concurred in representing it as a rock a little above water. Anxious looks were directed to the captain, whom they now considered as unnecessarily running into danger; but that officer kept carefully watching his approach, and, as the studding-sail boom was just over it, the cetaceous monster (for such it was) hastily made off; and, rising again to blow, finally disappeared. It was observed to have an excrescence on its back, covered with shell-fish. The sea broke gently on its weather side, and appeared becalmed to leeward; and so perfectly did it resemble a rock, that, had the vessel passed at a distance without disturbing it, there can be little doubt but it would now have had a place upon the list of vigias.

"It is to be observed, in this case, that there was only a little ripple about the body, but no breakers; and this circumstance had not escaped the intelligent eye of the commander."

The *dead* carcase of a whale may even approach nearer in appearance to a permanent danger than a living one. Captain Vidal, in H.M.S. *Styx*, while passing from Terceira to St. Michael's, on July 20th, 1844, the mast-head man reported the appearance of breakers on the starboard bow; the wind was West, and there was a little swell. "I have no hesitation in stating that this object (a dead whale) so much resembled a sand-bank, or a tide-rock at low water, that had I left it unexamined I should certainly have reported the probability of its being either one or the other, and in so doing I should have added another vigia to those which disfigure the charts of the North Atlantic Ocean."

A similar instance has been forwarded to us by Capt. T. Smith, commanding the *Liverpool*:—

"On June 8th, 1870, at 5.30 p.m., in lat. 40° 48′ N., long. 41° 26′ W., the chief mate reported an ice-floe on the lee bow; on going on deck I perceived

about a quarter of a mile to leeward, what appeared to be a mass of ice, with some dark-coloured substance on the centre of it; but, taking my telescope, I perceived it to be a dead carcase, probably that of a whale, with numerous birds swarming about it, the upper portion being dry, was probably dark coloured from exposure to the sun, as the blubber appeared to be off, and the colour dark brown, but all that was awash was perfectly white, with several undetached fragments floating around it, the whole mass heaving and undulating with the swell of the sea, which was washing against it, but not breaking; the *white* portion, however, might easily have been mistaken for broken water at a greater distance, and the *dark* portion for a *rock awash*. I doubt not but many of the reported dangers mentioned in your valuable 'North Atlantic Memoir,' and other Directories, have no other foundation; the visible portion might be about 40 feet by 20 feet in extent."

In 4° N., 24° W., a captain remarks (July, 1870), in his log:—"Passed through a shoal of *Bonitos*; there must have been thousands, and so closely were they packed that they tore the water into a white sheet of foam. At a distance they might have been mistaken for a reef flush with the water, having an area of about 100 square yards."

The following, also, at a distance, might deceive. In 6° N., 31° W. (September, 1864), a captain remarks—"Some *porpoises*, cutting extraordinary antics like acrobats." It is probable they were throwing themselves a great height out of the water, and allowing themselves to fall (as it were lifeless) on their sides, making a great splash. At any rate this is not an uncommon sight, and it is supposed by some that it is their way to rid themselves of parasites.

In every event, however, it is always the safer course, in matters of this nature, to err rather by marking too many than too few, especially when we make known, as we have done, the authority that we rely on for the existence of each. Every one, of course, is free to act according to his own judgment.

But on *all future announcements* of the discovery of rocks or shoals, it is absolutely necessary that they should be tested by the *sounding lead*. Without this they will not be considered as authentic.

In the first instance we give an account of those shoals which are well known, and also of those which are not absolutely disproved, though in many cases the question of their existence rests on the most slender grounds, yet it is just possible that some may be better authenticated hereafter.

1.—TO THE NORTHWARD OF LATITUDE 40°.

NUN ROCK, off Cape Wrath, in lat. 58° 52½′, long. 4° 56′ W.

This rock, with the adjacent bank, was surveyed, under an Admiralty order, by Captain Ramage, in the *Cherokee* sloop of war, 1817. It is a very dangerous isolated shoal, bearing N.E. by N. mag., or *N. 5° E. true*, from Cape Wrath, the N.W. part of Scotland, 15 miles distant. It is of small extent, not half a mile in diameter, with deep water all around it, and with 3¼, or, as some say, not more than 2¾ fathoms over it. It has been seen to break very high at half tide.

NORTH SHOAL, West of Orkney, lat. 59° 13′ 23″, long. 3° 34′ W.

One of the most dangerous shoals around the British Isles, as it is singularly isolated. It has but 7 ft. least water, is not larger than half the size of a boat, and with 30 to 40 fathoms around it. It bears from Noup Head, Westra, W. ½ N. 17 miles; Brough of Birsa, N.N.W. 9 miles; the Old Man of Hoy, N. by E. ¼ E., 2¾ miles.

Roche Bonne and the Banche Verte in the Bay of Biscay.

These are two reefs, lying within a short distance of each other, East of the Isle of Ré. Their position will be found already noticed, in the description of the coasts, &c.

Jones Bank, lat. 51° 23′ N., long. 14° 25′ W.

Notwithstanding the pains taken to ascertain the exact limits and character of the western edge of the bank of soundings off Ireland, it does not appear to have been definitely determined. For we have been favoured by Mr. Baharie, of Sunderland, with the particulars of a shoal cast of 30 fathoms, about 180 miles West of Cape Clear, lat. 51° 23′ North, long. 14° 25′ West. This is on the S.W. verge of the bank, with 470 fathoms 18 miles to the S.W. of it.

Jones' Bank, as this may be called, was found by Captain David Jones, of the barque *Achilles*, on August 18th, 1864. The vessel was becalmed, and the lead was hove, and showed 30 fathoms most unexpectedly, as above stated. He plumbed several times, and held on to the line, and found the lead at the bottom to drag over the uneven parts of the rock, and brought up a stone sticking to the lead.

Now when the nature of the adjacent coast is considered, it may be quite possible that this is an isolated hill of trap rock, like the lofty Skelligs, and may have a much less depth on some of its peaks. It is possible that the reported *Brasil Rock*, whose existence in the assigned position was disproved by Captain Hoskyn finding 2,350 fathoms may have some connexion with this.

PORCUPINE BANK, *to the westward of Ireland.*

During the examination of the sea-bed to the westward of Ireland for the purpose of finding the best locality for laying down the Atlantic telegraph cable, in H.M.S. *Porcupine*, Commander R. Hoskyn, the tail of a detached bank was unexpectedly crossed, August 8th 1862. "Carrying out a line of soundings on the parallel of Slyne Head, at the distance of 120 miles to the westward of it, we crossed the tail of a bank of 82 fathoms, coarse gravel. This being entirely new I have named it the *Porcupine Bank*. It will be of use to vessels bound to Galway from the westward as a means of ascertaining their position by the lead. The bottom, both to the northward and southward, is deeper, being composed of fine dark sand, while the bank is composed of gravel and coarse sand."

Dvina Rock (?), off Cape Finisterre, lat. 44° 45′ N., long. 9° 40′ W. (*Doubtful.*)

This announcement we received from Captain Grote, of the Russian Imp. Navy, when in command of the *Dvina*, the vessel which was hardly chased by our men-of-war in the Pacific during the last Russian war.

"On Jan. 14—26, 1853, the foretop look-out descried breakers right ahead, and we discovered it to be a rock. It is on a level with the water. Our observations gave us lat. 44° 43′ 6″, and long. 9° 37′ 23″ W. The sea was perfectly white with foam for about 200 fathoms." Captain Bessarabski made it to be in lat. 44° 48′, long. 9° 43′.

We have nothing to disprove the existence of this, and it is very improbable, but the position is remarkable. It must be left for future test.

The charts of Van Keulen, of the last century, showed a rock in 44° 43′ N., and 11° 22′ W.; but it has long been omitted as not authentic.

Midgley Shoal, in lat. 44° 9′ 30″, long. 22° 57′ 45″. (*Doubtful.*)

This shoal was discovered, or discoloured water was seen, by Captain Thomas Midgley in 1838, who describes it as follows:—"On the 14th of June, 1838, at 2.40 p.m., on my passage from Africa to Liverpool, I suddenly fell in with a large patch or belt of discoloured water, of a dirty gray appearance, much resembling river water, and *rippling very much*, as if upon a shoal bank. No rock or danger could be seen from the mast-head, but the water appeared very much discoloured for more than half a mile in breadth, as far as the eye could reach, in a direction N.W. and S.E. by compass. Position as above.

The late Captain Midgley was a man of perfect veracity, but the appearance might have arisen from other causes. At present we have nothing to contradict it.

Gough's or *Harrison's Rocks*, in lat. 40° 28′, long. 30° 0′. (*Doubtful.*)

These rocks appeared in the chart of M. Rochette, 1778, with the words "Rocks seen by Captains Gough and Birch." Van Keulen and Bellin have indicated several dangers in the vicinity to the N.E., but their existence has been denied by the pilots of the Azores.

Captain Livingston says:—"Captain Beaufort, of the brig *Concord*, of North Yarmouth, told me at Malaga, in 1820, that he twice saw Gough's and Birch's Rocks, when bound from Newfoundland to Lisbon; that one of them is about 12, and the other 3 ft. above water; and that they lie nearly in the longitude originally assigned them in the charts, and 5′ more to the northward."

Another report states that Gough's Rocks were seen by Captain Harrison, in the brig *Hope*, from the Sierra Leone to Cork, 17th April, 1830. lat. 40° 16′, long. 33°. At 11 a.m. two rocks appeared close under the lee-quarter. In smooth water these rocks would be even with the water's edge, and in the hollow of the sea Captain Harrison could distinctly see them 6 or 8 ft. down in the water.

Mr. Keen, of Liverpool, forwarded to us the account of their having been sighted by Captain Robertson, of the *Hugh Block*, in 1862, making it 10 miles farther North than the assigned position, or lat. 40° 38′ N., long. 30° 2′ 45″, the latter determined the day after sighting Flores. He says it would not be seen in smooth water, but as there was a low swell, it showed a surface of about 10 ft. covered with long rock weed.

Mr. E. S. Roberts, of London, also kindly forwarded to us, in 1874, the following extract from a letter he received from Capt. Hugh Mac Nulty:—

"In 1854 I was in command of and part owner of the ship *Frederick*, from Calcutta bound for Liverpool. In October of that year I was North of the Island of Corvo, one of the Azores; the breeze was moderate from E.N.E. I tacked ship to

the S.E., and afterwards saw Gough's Rocks, and passed within a cable's length of them, lat. 40° 30′ N., and about long. 31° 10′ W. They are flat rocks, about 250 ft. long and about 250 broad, and about 2 ft. above water; they bear from each other S.E. and N.W. by compass, E.S.E. and W.N.W. true; distance about 1 mile. I see by the 'North Atlantic Memoir' that these rocks have been seen at different times by Gough, Harrison, Birch, Robertson; and I find that they are left out of the new Admiralty Charts. They are very dangerous, being so far from land, and so much in the way of shipping thoroughfare. The Azores pilots might know something of them if they were close to land."

Nothwithstanding the non-verification of these reports by the sounding lead, which ought to invalidate them, and from the circumstance of the Azores pilots not knowing of them, there appears to be some reason for retaining them.

The bottom is not so deep here as elsewhere, for 830 fathoms only was found 20 miles to the North of Gough's, or 10 miles to the North of Captain Robertson's position.

Mossman Rock, lat. 43° 41′ N., long. 28° 51′ W. (*Doubtful.*)

The harbour master of Hartlepool announced the discovery of a rock a few feet above water, by his brother, Captain Robert Mossman, in command of the *Edward Kenny*, April 22nd, 1854, in the above position. It was confidently believed to be a rock, but no means are stated to have been tried to test it.

The repeated announcements of rocks in this neighbourhood, as is shown, although they do not hardly in any case appear to be seen again in the positions claimed for them, and the evidence of the deep soundings is against several of them, yet this repetition of discovery leads to the inference that some such rock as Mr. Mossman describes may lurk hidden here, and has given rise to these reports.

SAINTHILL or MILNE BANK, lat. 42° 37′, long. 41° 45′.

We have in this a very singular fact in hydrography. On two occasions very satisfactory soundings were obtained *near the same spot*, by British Naval officers, and yet both positions were unsuccessfully sought for by a third, as will be seen by the following:—

Lieut. A. Sainthill, R.N., commander of the ship *Beaufort*, on returning from Jamaica, August 3rd, 1832, when in lat. 42° 37′, long. 41° 45′, observed the water to be discoloured; in consequence of which he twice tried for soundings, and found rocky ground at the depth of 100 fathoms. But Commander Dayman found no bottom with 3,000 fathoms up and down in 42° 7′ N. and 41° 28′ W., about 32 miles off in September, 1858.

Notwithstanding that Commander Dayman's sounding of 3,000 fathoms so near Lieut. Sainthill's position (of which, however, he is not confident to half a degree of longitude), would apparently disprove its existence, yet Lieut. Sainthill has repeated his statement: "I can only tell you that I am perfectly convinced that we touched bottom, which Captain Dayman would call an excellent up and down cast. The arming of the lead showed sharp rocky bottom of fine blueish ashes, and my opinion is that we were over a submarine volcano in a state of eruption."—("Naut. Mag." 1861, p. 209.)

They were in appearance satisfactorily reconciled in 1864 by Admiral Sir Alex. Milne, in H.M.S. *Nile*, who found less water in the vicinity. In

our previous editions the paragraphs stood as above, and the name of *Beaufort Bank* applied to the position. But as a discoverer has every right to the credit of his announcement, we retained the name, instead of applying that of *Milne Bank*, as has been proposed. The following is Admiral Sir A. Milne's account:—

On the 28th of March, 1864, in lat. 43° 35′ N., long. 38° 50′ W., during the passage from Bermuda to England, the sea assumed a dark, dull lead colour, and soundings were obtained in 92 and 81 fathoms, and 12 miles E.N.E. 100 fathoms, fine sand and oaze.

I am inclined to think that a bank of some considerable extent exists in this locality, as the water for many hours previous to sounding was of the same peculiar tint, indicating soundings, and this appearance continued to the E.N.E. until the night of the 29th instant. This morning we regained blue water, and with reference to notices on the chart of 100 fathoms water (Sainthill, 1851), it strikes me as probable that this bank extends from long. 42° W. to 35° W., and from the lats. of 42° to 45° N.

This would appear to be quite decisive, yet the following extracts from the report of Commander W. Chimmo, R.N., who examined the vicinity in H.M.S. *Gannet*, in July, 1868, will show that its true position has not yet been found:—

We now sailed East for the spot where Lieut. Sainthill, in lat. 42° 37′ N., and long. 41° 45′ W., obtained, in 1832, 100 fathoms on the sharp rocky bottom, bringing up on the arming of the lead "fine bluish ashes;" and he was under the impression that he was over a submarine volcano in a state of eruption. At 2 p.m. on the 12th of July we reached this position, and with a heavy weight 4,300 fathoms of line ran out, and no bottom!

It was somewhat remarkable that about this place, within a radius of some few miles, many indications of shoal water had been from time to time seen and reported, one having as little as 35 fathoms on it. To one of these, called the *Milne Bank*, with only 80 fathoms on it, we were now steering. It had been found by H.M.S. *Nile*, in 1864, on her homeward-bound voyage; and, under most favourable circumstances, soundings of 89, 90, and 100 fathoms, "fine sand and oaze" brought up.

Lat. 43° 30′ N., long. 38° 50′ W.—At 4 p.m., on the 15th of July, we were on the 80 fathoms! The rod and weight of 230 lbs. let go, and as each 100 fathoms ran off the reel it caused some excitement, as at each fathom it was hoped the bank would be struck. 2,280 fathoms, 13,680 ft. ran out. There was no bank there. The rod brought up "oaze" abounding in animal, vegetable, and mineral!

Sept., 1868.—Another cast of the lead on the position of the Sainthill volcano quite disproved the existence of this vigia within a radius of many miles.

We were approaching for the second time the Milne Bank, of 80 fathoms; and although 2,300 fathoms was obtained on it a short time since, yet there was still a hope that the second attempt would be more successful, particularly as a telegram had reached me from England to the effect that "there was no doubt of the Milne Bank, as bottom was brought up *three* times;" and indeed so it would appear. But on the 3rd of September (lat. 43° 40′ N.,

long. 38° 50′ W.) the lead was again let go and 2,700 fathoms obtained, the rod bringing up a small but precious particle of Foraminifera.

Near the supposed position of this bank we sounded at short distances for some days with more than 1,000 fathoms of line; but in no case was there any indication of this bank. The last effort to sound in 1,000 fathoms North of this supposed bank will not easily be forgotten; it was obtained under many and great difficulties. The sea had risen to a fearful height in a very short time, which threatened to roll all the boats from the davits. My steam-cutter *Torch* did start. There was scarcely any standing on the deck. All the thirty-five men on the starboard side, while hauling the line in, lay down, or rather were thrown down on the line.

Lat. 43° 30′ N.; long. 38° 5′ W.—Sounded again with heavy weights in 2,000 fathoms, bringing up Foraminiferæ in various stages of growth; what gave interest and value to this sounding, was the fact that icebergs had reached these limits, proved by the presence of a piece of stone, three-quarters of an inch in size, deposited undoubtedly there by a berg, and brought up in the valve.

Lat. 30° 43′ N.; long. 37° 47′ W.—On the 5th of September a sounding was taken at 1,930 fathoms; the rod came up with its spring broken, but retaining sufficient of the bottom to show that it was down. Foraminiferæ, the usual deep-sea characteristic, appeared, mostly young and small, with transparent cells: about 6 per cent. of all these free from fracture, all the remainder fragments.

Before leaving the vicinity of the supposed bank, the temperatures here obtained with new and delicate thermometers at 2,000 fathoms was 42°—rather a higher temperature than expected. The air was 68°; the sea-surface 69°; while at 100 fathoms it had fallen 10°, and at 400 20°! At 1,000 fathoms it was 43°, after which it fell but 1° in 1,000 fathoms.*

The VIRGIN ROCKS, to the E. by S. of Cape Race; lat. 46° 26′ 30″, long. 50° 55′ 20″.

These rocks form a dangerous reef, lying about 30 leagues *E. by S. true*, from Cape Race; in gales of wind a heavy sea breaks over them, and a strong current, which sets about them, often increases the danger.†

These rocks, together with the surrounding dangers, including the *Ryder Shoal* to the eastward, are described in page 759.

CASHE'S LEDGE (Ammen's Rock), lat. 42° 56′ N. long. 68° 51′ 30′ W.

"This is a dangerous reef, about half a mile in extent each way. Its soundings are very irregular, having from 10 to 4 fathoms in the length of a boat. There are 17 fathoms within a cables' length of it, deepening a short distance to 90 fathoms, on the western side. On approaching the shoal you may find 60 to 35 fathoms, brown sand, with black stones and broken

* See Proceedings Royal Geog. Soc., vol. xiii. 1869, pp. 93-98.

† It has been stated (1859) by Captain Kewley, of Galway, that a shoal which breaks at times lies 4 or 5 miles to the S.W. of the Virgin Rocks. Perhaps it may be a shoaler patch on the bank on which the rocks rest.

shells; then 30 fathoms, where it becomes rocky. The currents on the ledge are exceedingly rapid and devious. On the shoalest part there are said to be only 12 feet at low water. By observations made, on four successive days, by the master of H.M. sloop *Beaver*, the latitude is 43° 1′ 0″. The longitude has been deduced from that of Cape Anne as from 69° 6° to 69° 12′."

The latitude of the rock, deduced from the two day's observations, June 5th and 6th, 1849, is 42° 56′; the longitude 68° 51½′ W. The least water on the rock is 26 feet; a less depth has been reported by the fishermen, but they sound with their fishing lines, perhaps not accurately marked, and with a lead insufficient to press down or pass through the thick kelp that covers the rock. The extent, having less than 10 fathoms, is about half a mile in a N.W. by W. and S.E. by E. direction, and very narrow. It is surrounded by deep water at a short distance, particularly on the S.E. side, where the depth increases suddenly to 60 fathoms.

GEORGE'S BANK.

These shoals were formerly described under the respective names of *Browns Bank* and the *Malabar Shoal*, by neither of which names they are now recognised. A copy of the report of an actual survey of them, made under the orders of Commodore Isaac Hull, by Mr. Feich, of the U.S. navy, and Mr. Edmund Blunt, jun., is contained in the "Colombian Navigator," vol. i. p. 56. From this report it appears that there are, properly, four shoals on the bank, the whole of them included between latitudes 41° 34′ N., and 41° 53′ 30″ N., and longitudes 67° 18′ W., and 67° 59′ W. The largest, which is toward the S.W., is also the most dangerous. Between the shoals are from 15 to 35 fathoms of water.

But these shoals have been accurately surveyed by Lieut. Charles Wilkes, of the U.S. navy, and the officers under his direction.

It appears by this survey that the general direction of the shoal ground is N.W. by N., and S.E. by S., and it extends 13 miles in length, and from 1 to 2 miles in width; the depth of water within this space being 10 fathoms and less, but very irregular. The two shoalest places are between 41° 40′ 13″ and 41° 40′ 33″ N., and 67° 44′ 10″, and 67° 40′ 30″ W. and are knolls of hard sand, having upon them, at low tide, 15 feet of water. With the exception of these two places, the shoal may be crossed in any part by an ordinary-sized vessel without danger. There is a rip usually the whole length of the shoal, and, at times, heavy breakers in the shoalest places.

Some other shoal patches of 5 fathoms lie at 28 miles to the S.W. by S., and 44 miles S.W. by W. of the shoalest spot, and are called the *Little George Bank*.

NANTUCKET SHOALS.

These very dangerous shoals, lying immediately in the line of traffic of the coasting trade of the United States, have been but very little known till within a very few years; and then their limits were more exactly defined at the expense of a private individual, Mr. E. M. Blunt, of New York.

These "Goodwin Sands" of the United States now, however, appear to be tolerably well examined, though still some doubt has been expressed as to whether their entire extent has been ascertained.

They have been surveyed by Lieut. Charles H. Davis, U.S. navy, superintending the hydrographic parts of this portion of the coast survey. The danger of these formidable shoals are reduced by the lighthouse on *Sankaty Head*, and also by the *Lightvessel*, described on page 771.

BETWEEN THE EQUATOR AND LATITUDE 40°.

Dædalus Rock, off CAPE ST. VINCENT, in about 36° 30′ N., and 9° 16′ W.
(*Very doubtful.*)

The old charts of the Atlantic indicated a danger at the distance of 12 or 15 leagues to the S.W. of Cape St. Vincent. This danger was omitted in the French chart of 1786, and subsequently in other charts, from the supposition that, if it really existed, it must have received some modern confirmation. But it seems, from information communicated by Captain Taylor, of the brig *Laurel*, of Whitby, that, in about 1813, the *Dædalus*, transport, struck on this rock, and received so much damage as rendered necessary for her to put into Lisbon for repairs. Captain Tayler was in the fleet when the *Dædalus* struck.

Added to this the brig *Briton*, Captain Stokes, was lost, in consequence of striking upon the rock, in December, 1821. After she struck she swung off, and then immediately tried for soundings, but got none. On finding the vessel sinking, the people took to the boat, and were picked up by another vessel. Captain Stokes had not seen Cape St. Vincent, but supposed it at the time to bear N.N.E. ½ E. 28 or 30 miles. This information has been communicated by Captain Livingston, who says, "This information was given to me in Malaga in September, 1822, by Captain T. Tankersly, of the schooner *Lord Mulgrave*, of London. Captain Tankersly added, that he had met with another master (name forgotton), who said he had observed the sea-weed on this rock; got out of his boat, and held on by some of the weed. He supposed the rock to be about 50 yards in circumference."

The preceding information is from Captain Livingston, who also says, "I was some years since informed by an old man of colour, a native of Goa, who was steward of a vessel I then commanded, that while he was cabin-steward to Sir Edward Pellew, while captain of H.M S. *Indefatigable*, she struck on a rock off *Cape Finisterre*. This, I understand, has been denied, and it appears true; for I have now information on which I can rely, from a very respectable naval officer, whose name I do not consider myself at liberty to mention, that the *Indefatigable*, when commanded by Sir Edward Pellew, actually struck on the rock, or a rock, off *Cape St. Vincent*, and received some damage. I had no doubt before that she had struck somewhere, as I had perfect confidence in my old steward's veracity; the error was in memory only."—(*Letter, 28th October*, 1822.)

The existence of this rock was affirmed on the 6th of March, 1839, by Mr. John Aves, commander of the schooner *Tantivy*, of Plymouth. At 9h 30m p.m., this vessel, on her voyage from Zante, passed close to the eastward of it; it was not seen till close aboard and not avoided without difficulty. There was a swell from the N.W. breaking over it, and a sheet of foam, about 20 to 25 fathoms in circumference. The *Tantivy* stood in N.N.E. on the port tack, till 7 next morning, then tacked to the southward, passing the cape at the distance of about 2 miles. The rock was thus

estimated to lie considerably to the eastward of its position, as shown by chart, and to bear about S.S.W., *true*, 37 or 40 miles from the cape.

That this rock does not not exist in the position usually assigned to it in modern charts is proved by the following, which we translate from the Annales Hydrographiques, part 3, 1875, page 473:—"The *Nautilus*, during her passage from Lisbon to Gibraltar, searched for the Dædalus Rock over its reported position, 30 or 35 miles S.W. of Cape St. Vincent, lat. 36° 30′ N. 9° 16′ W. Having previously determined the position of the ship by bearings of the land, she was steered direct for the N.E. portion of the area to be searched, and then cruised East and West 315 miles continually sounding. Of the 11 soundings tried, only one reached the bottom in about 350 fathoms, the others found no bottom between 90 and 130 fathoms. The weather was beautiful, with bright sunshine, the water of a deep blue, and the swell from the S.E. sufficient to indicate a danger by breaking over it. In the rigging 4 men were placed on the look-out for anything to indicate the danger, such as weeds, eddy, or breakers. But nothing was seen of the danger, and it was concluded, that it did not exist, or at any rate not in its assigned position."

H.M S. *Challenger* obtained a sounding of 1,000 fathoms 30 miles N. by W. of the position assigned to this danger, and another of 2,500 fathoms at 50 miles to the W.S.W.

We must leave this for the present. It is a blot on the charts; but still a rock may exist hereabout similar in character to Gettysburg Bank. Its existence ought to have been set at rest many years since.

GORRINGE or GETTYSBURG BANK.

Gorringe or Gettysburg Bank, lying between the Madeira Isles and Cape St. Vincent, at about two-thirds of the distance from the former, was first discovered by Commander Gorringe of the U.S. steam-sloop *Gettysburg*, in December, 1876, while engaged in carrying a line of deep sea soundings between Gibraltar and the Azores for telegraphic purposes. The bank was examined by Commander Egerton in H.M.S. *Salamis*, in March, 1877, this latter examination extending over four days.

The area of the Gorringe Bank, comprised within the depth of 100 fathoms, is nearly circular in shape, has an average diameter of 5 miles, and is included between the parallels of 36° 29½′ and 36° 34½′ N., and long. 11° 32′ and 11° 38′ W.

The shoalest part, within the depth of 35 to 30 fathoms, appears to be a narrow ridge 2 miles in extent, running nearly East and West; the least depth of 30 fathoms being confined to a small patch in lat. 36° 31½ N., and long. 11° 35½ W.

The nature of the bottom at depths under 50 fathoms was found to consist of rock and coralline matter; in depths exceeding 53 fathoms, pebbles, coralline substances, shells, and sand.

Beyond the depth of 100 fathoms the soundings increase rapidly. The depth of 1,000 fathoms from the shoal ground being about 5 miles in a northerly direction; 6 miles in a southerly; 13 miles to the westward; and 11 miles to the eastward. At 20 miles distant in a north-westerly direction, 2,750 fathoms were found, and in a north-easterly direction, 1,640.

The tide was observed in H.M.S. *Salamis*, when at anchor on the shoal ground, on 4th March (spring tides), to set regularly N.E. and S.W., with a maximum velocity of about 1½ knot.

Fish in abundance were caught on the bank.

FALCON ROCKS, to the Northward of PORTO SANTO.

The situation of these rocks has been already given in the description of the Madeiras, p. 687. They had previously been vaguely and erroneously described as a

bank, on which Francis Doublet, of Honfleur, grounded to the N.E. of Porto Santo; and as a ledge on which a Dutch ship was lost. It is most probable that it is the same shoal as the Eight Stones, which has been so frequently announced and unsuccessfully sought for, and now fully disproved.

Constante Reef, lat. 37° 56′ 20″, long. 33° 4′ 8″; and *Ferreira Reef*, lat. 38° 26′ 44″, long. 30° 25′ 10″ W. (*Doubtful*).

These two reefs were officially announced in October, 1840:—

"Manoel Mariano Ferreira, pilot, while navigating from Paraiba to Lisbon on board the Brazilian brig *Constante*, at 10 a.m., on the 26th of August, 1840, saw breakers to windward at the distance of 1 or 2 miles. The vessel remained in the same position for six hours, and in sight of the breakers. At noon, it being then higher water at that place, the surf had nearly disappeared; at 2 p.m. it again became perceptible, and at 6 p.m. a group of rocks was clearly visible above the water. By the latitude I had observed at noon, and the longitude given by a good chronometer, and the rock being about 1½ miles distant from me, I compute their situation to be in lat. 37° 56′ 20″ N., long. 33° 4′ 8″ West of Greenwich.

"On the 31st of August I passed near another sunken rock, which is marked in the chart as having been seen by Captain Robson to the northward of Fayal. At 8 a.m. I saw some rocks above water, over which the sea broke, and which I passed to leeward at the distance of 1 to 2 miles, in lat. 38° 26′ 44″, long. 30° 25′ 10″ W. of Greenwich.—*Lisbon*, 6th October, 1840."

The first of these reefs has been named the *Constante Reef*, and the second *Ferreira Reef*; they have been previously noticed, together with the *Pronk Rocks*, (Rhoon Rocks, in the "Nautical Magazine"), on page 683.

A shoal off Flores was originally copied from Van Keulen into Bellin's chart of 1742. Its position has varied from time to time. It cannot be authentic. By some it is called *Martyr's Shoal*, by the Portuguese *Vigia dos Azores*.

Near to the asserted position of the Constante Reef, Captain J. Keyzer, of the Dutch ship *Bato*, on May 5th, 1845, saw a white patch about 130 ft. in diameter. The sea smooth at the time. Lat. 37° 42′, long. 32° 57′.

We leave these shoals for future investigation.

Against their authenticity we have the authority of Captain T. D. Sickens, of the Dutch Marine, who passed over the spot with a good look out from the rigging, without seeing anything, and then steered N.W. by N. over Constante Reef, &c., with the same result.

Again a *volcanic shock* was felt, March 13, 1853, lat. 38° 9′ N., long. 31° 55′.* Near to this, however, the sea is 2,000 fathoms deep.

At all events much circumspection is necessary in sailing through these parts.

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* The repeated accounts which have been given of earthquake phenomena hereabout ought to induce caution. Their range appears to be wide, for on November 25th, 1857, W. Cook, of the *Estremadura*, bound for Fayal, when in lat. 39° 57′, long. 25° 50′, saw abaft the beam what was thought to be a squall, but which turned out to be a kind of mist or warm steam, which lasted half an hour; wind N.E. The waves then changed to a kind of boil, or topping sea, as if surged up from beneath, but it returned to its former state, when the mist was passed.—(Lloyd's List, Jan. 11, 1858.)

Again in 1858, Nov. 11th, at 7.45 a.m., the *Venus*, when 30 miles N.N.W. from Cape St. Vincent, Portugal, was seized with a violent trembling, as if caused by some volcanic eruption; the shock was felt by all the crew, and lasted about 15 seconds; the noise resembled the rumbling of thunder.

Keus, or *Europa Rock*, lat. 38° 15′ N., long. 22° 14′ W. (*Doubtful.*)

Capt. D. Keus, of the Dutch ship *Europa*, stated, in a letter to H.E., the Minister of Marine, that on the morning of December 10th, 1853, he saw a "*black mass*," to the S.W. by W., steering N.E. by compass; at day-break he saw that it was a rock or reef, and passed it about 2 miles distant. Its height was about 15 or 20 ft., and it is about 200 ells in length. Capt. Keus places this rock in lat. 38° 15′ N., long. 22° 14′ W. Its existence is very doubtful.

St. Mary's Bank, to the South of the Azores, in about 35° 53′ N., and 27° 19′ W. (*Very doubtful.*)

"On our passage, in 1819, from Havana to Barcelona, we passed over white water, apparently a shoal, to the southward and westward of St. Mary's. The captain would not allow the vessel to heave-to in order to sound; but I have no doubt in my mind of its being a very extensive bank of soundings; and I have little doubt that I have ascertained its position, tolerably accurate, from lunars, prior and subsequent. I should not be surprised if it turned out that the bank we passed over was connected with the Kutusoff Bank, marked, in the last edition of Admiral Espinosa's chart, as having been seen in 1816, and which lies to the S.W. of the one we passed over, at the distance of about a degree. We were some hours crossing the bank.

"The bank lies in lat. 35° 53′ N., as calculated by account between the observations of the noon before and noon following; long. 27° 19′ W. I have heard a gentleman, a lieutenant de vaisseau, mention what I suppose to be the same, at the table d'hote, at St. Michael's, in October, 1818."—*A. Livingston.* This is all we still know, but it is not absolutely disproved.

Chantereau's Shoal, in lat. 38° 27′, long. 38° 0′. (*Doubtful.*)

This shoal, described as a white rock, was said to have been seen by Captain Chantereau, of the ship *L'Auguste*, in lat. 38° 24′, long. 41° 35′, in coming from Martinique, September 6th, 1721, when the sea broke on it very much. It was again announced by Lieutenant Edm. Scott, commanding the *Princess Elizabeth* packet, 24th April, 1828. Lat. 39° 14′, long. 39° 49′ W.

According to a notice inserted in the official copies of the *Derrotero de las Antillas* and dated Madrid, July 4th, 1846, a shoal or vigia was discovered at 3 p.m., May 21st, 1846, in fine weather, by D. Gabriel Perez, captain of the Spanish merchant ship *Leontina*, in lat. 38° 27′ N., long. 37° 57′ 10″ West of Greenwich, according to observations made shortly before seeing the rock, and confirmed by chronometer in making Graciosa (Azores) soon after.

Here we have three announcements of dangers of similar character in close proximity. If it exists, they are probably the same. We have no further evidence in its favour or to contradict it. But at 74 miles eastward of it, the *Dolphin* found 2,675 fathoms.

Marsala Bank.

Captain G. B. Fasce, of the Italian ship *Marsala*, reports:—On April 19th, 1877, being in lat. 33° 42′ N., long. 34° 25′ W., observed a discolouration of the water, and on reaching the spot, in lat. 33° 55′ N., long. 34° 17′ W., sounded in 82 fathoms, hard bottom. A second cast, in lat. 34° 1′ N., long. 34° 9′ W., no bottom at 123 fathoms. The water resumed its blue colour after sailing a few miles.

Challenger Bank, S.W. of Bermudas.

This bank was examined by H.M.S. *Challenger*, in April, 1873, and Sir Wyville Thomson,* after speaking of the soundings at about 2,000 fathoms between the bank and Bermudas Island, says:—"In the evening we sounded in 32 fathoms, about 13 miles to the S.W. of Bermudas; this is a bank well known to the Bermudas fishermen, and is said to have been discovered from the large number of fish swimming near the surface. We anchored on the bank, and the fishing lines were soon out, but we were very unfortunate, for only one or two 'snappers' were taken. . . . The bank, which seems to be about 5 miles across, consists mainly of large rounded pebbles of the substance of the Bermudas' Serpuline reef. There is an abundant growth all over the pebbles of the pretty little branching corals *Madracis asperula* and *M. hellena*, and other invertibrates were abundant. . . . . As the weather did not look by any means promising, we weighed anchor, and proceeded on our course to the N.W."

Deep Soundings S.E. of Bermuda. (*Doubtful.*)

The "New Bedford Mercury" relates an account of some soundings which were supposed to be obtained in the ship *Chaucer*, in April, 1850, but which were fallacious, as follows:—"Here, in lat. 27° 10′ N., long. 62° 45′ W., on the 20th of April, 1850, the nearest land being Bermudas, bearing N.W. by N., and distant 345 miles, water blue, with much gulf-weed, weather calm, no current, the boat was lowered; let run the lead, and got bottom in 774 fathoms. April 15th, lat. 27° 31′ N., long. 60° 3′ W., Bermudas N.W. by N. 300 miles, sounded and got bottom in 366 fathoms. April 29th, lat. 29° 20′ N., long. 64° 11′ W., Bermudas N. by W. 160 miles, sounded and got bottom in 620 fathoms.

The time occupied in running out the line varied from twenty to thirty minutes. The line was constructed thus: first 100 fathoms, five parts of shoe thread; second, four parts; third, three parts; fourth, two parts; remainder, single. The lead weighed about five pounds; the whole wound upon a light reel, and held by hand. In this process of obtaining soundings the lead is not to be hauled up."—"Daily News," August 28th, 1850.

There is no doubt but that the imperfect means deceived the commander as to finding bottom; for Captain Lee, U.S.S. *Dolphin*, got a good sounding of 3,828 fathoms, the deepest obtained in the cruize a degree to the South of that reported of 366 fathoms, and no bottom with 1,000 fathoms near that of 620 fathoms, and 3,080 fathoms have been got near that of 754 fathoms.

Aylen, or *Porgas Bank*, East of the Cape Verde Islands. (*Very doubtful.*)

The following is from the log of H.M.S. *Hydra*. "August 1st, 1868. 16° 17′ N., 19° 43′ W. Sounded on the eastern edge of the alleged Porgas Bank, obtaining 1,880 fathoms oaze; noon, crossed the alleged position of Porgas Bank; no indication of shallow water. In 16° 46′ N., 19° 45′ W., sounded on a patch marked 86 fathoms *Birkenhead*, obtaining 1,850 fathoms, brown sand and mud."

This latter sounding is about 20 miles S.E. of the position of the 82 fathoms sounding of the *Birkenhead*. Below we give the description as it appeared in previous editions of this work.

In the early charts of the Atlantic this bank has always been shown, as extending

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* Voyage of the *Challenger*, the Atlantic, vol. i., pp. 359–361.

50 leagues in length N. and S., with a breadth of 5 leagues. Nothing more than this appeared to be known of it except the statement that it was all deep water, and not dangerous to shipping.—(*Oriental Navigator*, p. 27.) It was unsuccessfully sought for by the *Leven* in 1819. In some later charts it had been omitted for want of some confirmation, but this seems to be revived by a cast of the lead taken in the *Birkenhead* steamer, in her voyage to Ascension, under the command of Mr. J. B. Aylen, R.N., on November 11th, 1850.

The position, carefully deduced from chronometer and observation, is 17° 0′ N., long. 20° 3′ 15″ W., and the depth 86 fathoms. The bottom appeared to consist of pieces of shells and sand, or small particles of coral. Mr. Aylen says, that "I did not like heaving the ship to, to take another cast, particularly as I considered myself on the edge of the bank only, and that at noon, when on its centre, I would again try, which I did without success with 90 fathoms of line.—*Nautical Magazine*, 1851, page 155.

The following is an extract from a log examined at the Meteorological Office:—"Here is the position of the Porgas Bank, according to the old charts. *Birkenhead* in 1850 got 86 fathoms close to this position; we sounded at noon in 17° 10′ N., and 20° 32′ W., with 150 fathoms; got no bottom.

Besides this sounding hereabout, another of 164 fathoms was obtained, in 1819, by Captain Fréminville, to the N.W. of the cast of Mr. Aylen, in lat. 11° 35′, and long. 21° 40′.

This concludes the description of every shoal about which it is thought there can be any possibility of identification hereafter, but, as before stated, it is barely possible that several do exist.

The next list, in a tabular form, enumerates those which are still more open to doubt. The particulars of each announcement are given in full in old editions of this work.

TABLE A.

ROCKS, ETC., WHOSE EXISTENCE IS VERY DOUBTFUL.

Name.	Reported by	Date.	Lat. N.	Long. W.	Particulars.
			° ′	° ′	
Amplimont Rocks	Guichardi ..	1735	42 30	24 5	30 ft. high.
———	Mills	1829	42 30	24 5	,, ,,
———	Alderson	1842	42 51	24 15	8 or 10 ft. high.
———	Duff.....	1846	42 56	24 30	Awash.
Birkenhead, 82 fathoms	Aylen	1850	17 0	23 3	1,850 fathoms near.
Chantereau's Shoal	Chantereau..	1721	38 24	39 25	
———	Scott	1828	38 16	38 49	(Or Princess Elizabeth Shoal.)
———	Perez	1846	38 27	37 57	
Columbine Shoal	Robertson ..	1844	35 25	49 1	Not sounded.
Constante Reef	Ferreira	1840	37 56	33 4	
——— (Martyrs, or Agore's Reef)	Keyzer	1845	37 42	32 57	A white patch. Position doubtful.
Dædalus Rock	Taylor.....	1813	....	....	
———	Stokes.....	1821			

Name.	Reported by	Date.	Lat. N.	Long. W.	Particulars.
			° ′	° ′	
Dædalus Rock	Aves	1839	36 30	9 16	Position doubtful.
Delaware Shoal	Ross	1839	10 37	60 3	5 fathoms. Doubtful.
Devil's Rock	Brignon	1737	46 55	13 0	
———	Thomas	1764	46 24	13 10	
———	Peter	1818	46 35	13 7	
———	Henderson..	1829	46 33	13 2	
———	Livingston ..	1826	46 9	12 50	2,350 and 2,190 fathoms found near.
———	Swainson ..	1829	46 35	13 8	
Dvina Rock	Grote	1853	44 43	6 37	Not sounded, nor seen since.
Ferreira's Reef	Ferreira	1840	38 26¾	30 25	Awash.
Gough's Rocks	Gough	1778	40 28	30 0	830 fathoms near it.
———	Beaufort....	1820			
———	Harrison....	1830	40 16	33 0	
———	.....	1862	40 38	30 3	Just awash.
Hilton Rocks	Hilton.....	1845	39 18	35 50	Nearly awash.
Keus Rock	Keus	1853	38 15	22 14	A black mass, 20 feet high.
Kutusoff Bank	Espinosa....	1816	35 0	28 30	Perhaps St. Mary's Bank.
Martyr's Shoal. *See* Constante.					
Mossman Rock	Mossman ..	1854	43 41	28 51	Above water.
Midgley Shoal	Midgley	1838	44 9½	22 57¾	Discoloured water. Not sounded on.
Munn's Reef	Munn	1827	39 0	64 20	20 fms. white sand. Position undeterm.
Neva Rocks	.....	1856	31 10	34 40	4 feet above water.
Perez. *See* Chantereau.					
Princess Elizabeth Shoal. *See* Chantereau	Scott.				
Rockall	Harvey, &c.	1810 &c.	....	....	Surveyed by Captains Vidal and Hoskyn.
Ryder Shoal	Ryder	1845	46 30	49 35	21 ft. water. Position doubtful.
St. Mary's Bank	Livingston ..	1819	35 53	27 19	White water.
Westenenk Shoal	Westenenk..	1840	31 58	40 28½	Breakers.

The second list shows those rocks, &c., which may be safely considered as absolutely disproved, and in most cases are not shown on the chart; when they are placed there, they have (??) attached to them.

TABLE B.

ROCKS, ETC., REPORTED BUT DO NOT EXIST.

Name.	Reported by.	Date.	Lat. N.	Long. W.	Particulars.
			° ′	° ′	
Aitkin's Rock	Aitkin	1740	55 18	11 14	Not found in search of 1824, 27, 29, and 30.
———	Ship *Nestor* ..	1793	55 19	9 53	
———	.....	....	55 15	10 40	
———	Reid	1826	55 17	....	
———	Craig	1852	55 15	9 56	
Akett. *See* Daraith					
Alof Kramer's Bank	Kramer	....	60 57	16 40	Not found, 1818.
America Rock	Ship *America*	1846	40 20	63 50	Probably a wreck.

Name.	Reported by.	Date.	Lat. N.	Long. W.	Particulars.
			° ′	° ′	
Anna Rock	Carmelich ..	1841	39 30	50 30	Probably an iceberg.
Anfitrite Shoal	Ship *Anfitrite*	1846	35 50	66 4	No bottom at 1,000 fathoms.
Ashton Rock	Guy.....	1824	33 49	71 41	Very improbable.
Atila Rock	Ship *Atila* ..	1856	36 31	32 24	Sunken.
Barencthy Rock	.....	....	45 33	37 25	Not found.
Beazley Shoal	Beazley	1841	40 45	36 47	Almost awash; (2,755 fathoms near.)
——— Spanish Shoal	.....	1769	40 26	36 5	5 fathoms.
——— Ditto	Wahlstein ..	1857	40 26	36 10	Sea broke over ship.
Bell Rocks	Bell	....	33 45	55 25	Not found.
Betsey's Rock	.....	1808	18 7	50 0	2,370 fathoms near.
Blaesdale's Reef	Blaesdale ..	1819	0 57	41 6	2,980 fathoms found.
Bom Felix Shoal	Dultra.....	....	19 20	20 37	Not found, 1838.
Bonetta. *See* Emily					
Bouvet's Sandy Island	.....	1761	....	....	Not found, 1838.
Brasil Rock	Brouage and Laisne.	1742	51 10	19 10	Not found.
———	.....	1791	....	16 0	Not found.
Breton's Rock	Breton.....	....	39 45	41 25	2,675 fathoms near.
———	Ship *Tiger* ..	1816	39 40	41 40	
Bus, Sunken Land of	.....	....	58 0	33 0	
Cæsar Breakers	.....	1730	2 0	22 18	Not seen, 1856.
Candler's Rock	Candler	....	39 47	34 29	Incredible.
Chaderton Rock	Chaderton ..	1858	44 56	32 51	Awash. 1,500 fms. nr.
Chapelle Rock	Houel	1764	....	....	Not since seen.
———	Ship *Favorite*	1822	47 37	8 2	Broke. ,,
———	Tasker	1842	47 43	8 4½	Sunk 4 ft. ,,
———	Vaillant	1857	47 30	8 5	Sunk 2 or 3 ft. ,,
Chaucer Bank, 366 fms. Clark. *See* Mayda.	Ship *Chaucer*	1850	27 31	60 3	3,825 fathoms near.
Cleveland Reef	Cleveland ..	1765	30 45	10 20	Very doubtful.
Clowes Reef	.....	1817	10 17	65 50	Not found.
Coral Shoal	.....	1822	0 30	29 35	*See* Mossman Rock.
Corsair. *See* Akett, Daraith, &c.					
Courier Rock	Thompson ..	1849	27 51	78 31	Part of Maternillo Reef.
Daraith's Rock. *See* Akett, Hamilton, and Watson	Daraith	1700	40 50	54 53	Probably ice. 2,710 fathoms found.
Desmaires' Rock	Desmaires ..	1683	42 0	41 10	*See* Druid's Reef; perhaps ice.
Druid's Reef	Treadwell ..	1831	41 19	41 25	Perhaps ice.
———	Spanish Chart	1803	41 24	41 20	Ditto.
Dubreuil's Vigia	Dubreuil....	1753	14 50	29 40	*See* Tregarthen and India Shoal.
Dyet Rock	Dyet	1845	32 46	60 6	550 fathoms on it.
Eight Stones	Vobonne....	1732	34 37	16 40	Perhaps disappeared.
Emily, or Bonetta Rock England. *See* Mayda.	Ship *Emily*..	1845	16 59	21 30	1,580 fathoms near.
Esmeralda Rock	Ship *Esmeralda*	1856	45 13	16 48	2,200 fathoms near.
Falconer Rock	Falconer.....	1847	38 40	29 8	Improbable.
False Bermudas	Duhal	....	32 10	58 10	Same as Dyet Rock.
Fields' Vigia	Fields	1853	37 31	66 0	No bottom at 1,175 fathoms.
Five Heads	Van Keulen	1757	44 15	19 25	Not since found.
French Shoal	Spanish Chart	1796	4 5	20 34	2,670 fathoms near.
———	French Chart	....	4 15	19 20	
———	Log in Met. Office	....	4 4	22 25	
Galissionière's Rock, or Fonseca Island	Galissionière	....	12 20	54 49	2,570 fathoms found; perhaps volcanic.

Name.	Reported by.	Date.	Lat. N.	Long. W.	Particulars.
			° ′	° ′	
Galleon's Bank	Longueville	1730	15 56	49 40	Probably volcanic shock.
Gandaria Rocks	Gandaria ..	1842	25 30	37 45	1,720 fathoms found.
Gargas, Baxo das	.....	....	13 0	29 60	Very doubtful.
———	Louv. e Pinho	1848	12 30	28 56	Ditto.
Gilchrist Rock	Gilchrist....	1848	32 0	21 48	Not sounded. *See* Josyna Rock.
Gombaud's Rock	Gombaud ..	1764	23 15	32 25	2,200 fathoms found.
Green Rock, or I. Verte	Le Boccage .	1742	44 52	26 25	
Greeve's Ledge	Greeve	1745	44 15	25 5	1,850 fathoms near.
Guigou's Bank	Guigou	1688			
———	Whipple....	1733	20 50	66 45	2,960 fathoms near.
Hamilton	Hamilton ..	1851	40 25	54 28	Probably ice.
Hannah's Breakers	.....	1791	20 0	63 50	
Hannah's Coral Shoal	Fanning	1824	10 7	27 32	No bottom at 2,000 fathoms.
Henderson Bank, 48fms.	Henderson ..	1850	42 45	29 0	1,210 fathoms found.
Hervagault Breakers	Hervagault (& Max.), 1823	1723	41 2	49 23	Probably ice.
———	Lourp	1816	41 6	49 57	Ditto.
———	Marquand ..	1855	40 27	49 56	Ditto.
Huntley's Rock	Huntly	1833	30 49	78 27	Improbable.
India Shoal	.....	....	15 45	27 20	Very doubtful. *See* Tregarthen Rock.
Inglefield Bank	Inglefield ..	1810	29 42	80 17	Edge of bank of soundings.
Jaquet Island	Le Gros	1836	46 55	39 30	Probably an iceberg.
Jean Hamon's Rock	Hamon	1733	36 54	19 49	Not since seen.
Job Rock	Job	1858	46 25	35 40	Probably ice.
Josyna Rock	*Josyna* lost..	1697	31 40	23 45	*See* Gilchrist Rock.
Laidman Rock	Laidman....	....	46 0	26 0	Probably volc. shock.
Lean Shoal	Lean	1854	45 32	11 57	Heavy breakers.
Longchamps Rock, or Solis Island	.....	....	9 47	30 0	Not seen 1851.
Lourp. See Hervagault					
Maalstrom	Van Keulen .	....	16 0	37 0	Not fd. in 1799 or 1869.
Maria's Rock	Sch. *Maria*..	1813	19 45	20 50	No bottom at 300 fms.
Marinero Rock	Swinton	1831	46 0	30 0	1,760 fathoms near.
Marquand. See Hervagault.					
Martin's Reef	.....	1742	....	....	3,200 fathoms found.
———	Martin	1816	....	....	
———	Ship *Cecilia* .	1823	16 44	58 50	
———	Newbold....	1842	16 42	59 6	
Mourand's Bank	Mourand....	1773	24 34	65 10	3,500 fathoms found.
Mayda. See Five Heads					
——— ditto	Biden	1738	46 10	19 40	
———	Clark	1842	45 40	19 17	
———	England	1840	46 36	19 30	
Negre's Rocks	Negre	1722	48 8	20 30	
———	Bauve	....	48 7	21 21	
Orion Rock	Luytjas	1845	34 51	72 28	Improbable.
Patty's Overfall	.....	....	11 0	24 30	Not found 1838.
Perseus Shoal	Ship *Perseus*.	1813	41 3	22 30	Not since seen.
Porgas	Old Charts..	....	16 17	19 43	1,880 fms. near, see page 799.
Potomac Soundings, 90 fathoms	Smith	1838	38 10	67 26	No bottom, with 4,200 fathoms near it.
Prince Shoal	Thomas	1853	0 54	26 50	Volcanic shock.
Pronk Rock	Pronk	1844	38 32	33 16	1,500 fathoms near.
Pryce Shoal	Pryce	1846	3 7	24 14	*See* Cæsar Breakers.
Ramigeau's Vigia	.....	....	42 42	37 30	
Roallon's. See Three Chimnies.					

Name.	Reported by.	Date.	Lat.N.	Long.W.	Particulars.
			° ′	° ′	
St. Esprit Reef - -	Sh. *St. Esprit*	1817	14 37	53 59	Not found in 1833-4.
——— - -	Ld. W. Paget	1833	....	....	Perhaps volcanic
Smith or Wallace Bank	Smith	1856	49 36	16 17	Improbable.
Spanish Shoal. See Beazley - - -	.....	1769	40 26	36 5	
Spanish - - -	.....	1798			
Sprigg Rock - -	Sprigg.....	1842	46 12	15 3½	
Steeng round - -	Bellin, &c. ..	....	32 20	20 50	Not found.
Texeiro's Shoal - -	Texeiro	1810	12 0	33 28	Breakers.
——— - -	Heron	1824			
——— - -	Roallons....	1842	47 37	28 51	
Three Chimnies - -	De Cl. Fernel	1729	47 54	29 40	Probably ice; 1,900 fathoms found.
Tregarthen Rock -	Tregarthen ..	1856	14 29	26 30	See Dubreuil's Vigia or India Shoal.
Tulloch Reef - -	Tulloch	1808	37 27	24 45	Volcanic; may have disappeared.
Tulloch Overfalls -	Tulloch	1819	24 11	61 44	3,450 fathoms.
Verte Isle. See Green Rock - - -	Le Boccage..	....	44 52	26 25	
Vigia - - - -	.....	....	37 50	34 18	
—— - - -	Spanish Chart	1798	43 30	37 35	Probably ice.
—— - - - -	French Chart	1746	55 24	24 40	
—— de Five Palmas or Hinman's Shoal -	.....	....	12 0	27 20	
Wahlstein Breakers -	Wahlstein ..	1857	40 26	36 10	See Beazley.
Walker Shoal - -	Maury's Charts	....	4 14	27 36	2,100 fathoms near.
Warley's Shoal - -	Ship *Warley*	1813	5 4	21 25	Not found in 1838.
Watson's Rock - -	Watson	1824	40 18	53 40	Probably ice. See Daraith, Akett, Hamilton.
Whale Rock - -	Gradun	1809	38 46	24 47	
Woodall's Rock - -	Woodall	1829	43 20	25 10	1,850 fathoms near.
——— Vigia - -	Surgeac	1750	40 53	52 0	Probably ice.
——— Shoal - -	Spanish Chart	1798			

We have thus concluded the catalogue of dangers and presumed dangers which have been stated to exist to the embarrassment of navigation, and which have for so many years "disfigured our charts." As will be seen, the direct test of the sounding lead has caused the disappearance of most of them; and, as was at first stated, they are only retained to show the reasons upon which they may be ignored.

The chart illustrating the depths of the North Atlantic, given hereafter, further shows the improbability of the existence of these dangers.

VOLCANIC REGION.

In the neighbourhood of the Equator, and between longitudes 18° and 23° W., is a space which has been very fertile in former years in the production of supposed rocks and sand-banks. The nature of this space is now better understood, and we have now only the frequent announcement of volcanic shocks having been felt. They are indeed very numerous, and in

our South Atlantic Memoir, 8th edition, pp. 208—214, we have given a series of these occurrences. They need not, therefore, be repeated here.

It is now well known that the effects of an earthquake or *tremora* at sea has exactly the same effect on vessels as if they had rubbed over a reef of rocks, or the heavy cable had suddenly run out. We have many instances of this, and such effects may be looked for in crossing the Equator within these limits. It may perhaps extend as far to the West as the volcanic islets of Peñedo de San Pedro.

To the list given before, as above stated, we may add, by way of example here, the following:—

Capt. Ballaird, of the ship *Rambler*, from Calcutta, on October 30th, 1850, in lat. 16° 30′ N., long. 54° 30′ W., and Capt. Potter, of the barque *Millwood*, last from Rio, half an hour later on the same day, when in lat. 23° 30′ N., long. 58° W., each felt a volcanic shock. These vessels were about 520 miles apart. Supposing them to be in the direct line in which the earthquake was travelling, its rate will appear to be about 1 mile in 5 seconds, which is only a little slower than sound travels through the air.

The U.S. sloop *Vandalia*, December 15th, 1859, near midnight, in lat. 17° 34′ N., long. 55° 49′, experienced the shock of an earthquake, which lasted 5 seconds, and was accompanied by a low rumbling noise, and strong vibration throughout the ship. The wind, which was N.E., immediately veered to East, and decreased.

The Russian ship *Dallas*, W. Wikander, commander, March 20th, 1861, at 7 p.m., lat. 0° 27′ N., long. 20° 30′ W., the ship apparently went over the ground; the ship's masts and yards were shaken. Found afterwards that the false keel had gone.

At the same moment another ship, the *Melbourne*, of Dundee, C. Cowie, master, in lat. 0° 20′ N., long., 20° 35′ W. (that is 8½ miles distant from the Russian ship, in company), was startled by hearing a loud rumbling noise, and at the same time felt the ship tremble from stem to stern, which lasted 4 or 5 minutes.

The ship *Florence Nightingale*, January 25th, 1859 (1 p.m.), having the St. Paul Rock, or Peñedo de San Pedro, bearing N.W. by N. 10 miles, experienced a severe shock. It commenced with a rumbling noise like distant thunder, and lasted about 40 seconds. During the first part (? of the day), there was a small confused sea, but after the earthquake a heavy swell from N.N.E. I am perfectly familiar with earthquakes, having experienced many on the West coast of America, but I never felt one so severe as this. Glasses and plates that were on the table jingled to a great extent; several articles were shaken off the after hatch, and the ship felt as if grinding heavily on a reef of rocks, which idea found general belief, for the cry of "The ship's ashore!" burst simultaneously from the lips of all on board, and the watch below came tumbling up in great haste. I must confess that I was very much startled, and ran to the side to look for bottom, but soon remembered what it was, and allayed the panic by explaining that 'was only an earthquake."

The following must refer to the same shock, as it occurred within half an hour of the time of the preceding.

In about 0° 6′ N. and 30° 28′ W. (0^h 30^m p.m.), about N.E. by E. 84 miles from the position of the last-named ship *Florence Nightingale*, 25th January, 1859:—"Experienced a shock on board, the vessel trembling and heeling over, the sensation being something similar to that of a vessel dragging her anchor in a tideway. The shock lasted about 1½ minute; it was evidently the effect of some volcanic agency. It was so distinctly felt as to alarm all hands. There was nothing peculiar in the appearance of sea or air. The weather was squally with showers of rain."

Captain Whitmore, of the *Sea Serpent*, December 29th, 1859, struck, as he supposed, on a coral reef, in lat. 0° 29′ N., long. 28° 30′ W., in consequence of which he put into Rio. He sounded immediately, and found no bottom, but found afterwards his false keel and copper injured.

The Russian sloop of war *Passodnik* struck, as was supposed, on the same shoal, about twenty-four hours before the *Sea Serpent*, but this proves the nature of the occurrence.

The *Prince*, of Scilly, James Thomas, commander, December 11th, 1853, in lat. 0° 54′ N., long. 26° 50′ W., smooth water, suddenly felt a grinding tremour go through the vessel, as if dragging over something rough and yielding. It continued for about a ship's length, but did not stop her way through the water. The ship did not strike.

The ship *Maid of Judah* felt a slight shock September 15th, 1855, in lat. 1° 30′ N., long. 25½° W. Strong swell from the southward.

The barque *Eleanor*, Captain G. A. Findlay, March 26th, 1861 (10 a.m.), felt a shock as if something very heavy was being rolled about the decks, or as if the ship had gone over some rough ground; it made the vessel tremble only for a few seconds. A rumbling noise heard like distant heavy thunder. Weather remarkably fine; lat. 0° 44′ N., long. 21° 19′ W. Great quantities of fish and sharks around the ship.

These instances, with the others, will afford ample evidence of the general nature and locality of these volcanic shocks.

We have limited the instances here to this particular area on the Equator; but there appears to be either an extension of this action far to the northward, or else there is a separate area, for volcanic shocks have been felt as far North as 23° 30′ N., and long. 58° 0′ W.; and from the almost continuous line of discoloured and peculiar water that extends from the Equator to this position, as will be presently stated, we are led to infer that there is a line of volcanic action trending parallel to the range of the Antilles.

The depth, however, is very great, and there is not now any reason for supposing that any shoal exists. Lieutenant Lee and others have found depths exceeding 2,000 fathoms over most of the region in question; and this is another wonderful evidence of the force of these shocks which can be transmitted through a stratum of water 12,000 feet and upwards in thickness.

DISCOLOURED WATER.

At 3 p.m. on the 15th of July, 1792, Don Cosme de Churruca, then on his passage to the West Indies, discovered a boiling and breaking of the sea, so very extraordinary, that it appeared to be breakers; but they found no bottom at 150 fathoms. This phenomenon, which appeared to be in consequence of a current setting against the wind, accounts for the differences between the observations and dead reckoning.

On the 16th, at 10 a.m., they were in lat. 13° 56′, long. 54° 7′ West of Greenwich, and observed that the colour of the water changed, looking like muddy river water, or as if they were on a bank. They were 128 leagues to the eastward of the middle of St. Lucia, and 150 leagues to the N.E. of Orinoco. They continued their course without alteration; sounded at night and found no bottom at 120 fathoms. The Captain, Churruca, says that the colour is always the same in that part of the ocean, always appearing as if on soundings in that latitude and longitude, and that it never varies the position of its limits; and, in addition to his own remarks, he had assured himself of the fact by information collected from various sources; and that, also, the English Sailing Directions for the year 1782, entitled the "Complete Pilot for the Leeward Islands," in the account of Barbados, mentions that this phenomenon is found at the distance of 70 or 80 leagues to the eastward of that island, and that there are no soundings, though the water seems as if there were.*

The passage above quoted, from the old Book of Directions, is as follows:—

"In the latitude of Barbados, about 70 or 80 leagues to the eastward, you will find the water discoloured and prodigiously thick, as if there were soundings, but there are none, and you may depend on being at the distance aforesaid from the island." †

"In alluding to Mr. Luccock's remarks about the patches of water which exhibit a brown and dirty appearance, and also to the note from Captain Kotzebue in the 'Sailing Directory for the Ethiopic,' p. 42, I should question with all deference, whether the depth of water in such places was tried to a sufficient degree of certainty.

"On our passage from the West Indies to Europe in July, 1837, at about four in the afternoon of the 7th, a streak was observed on the surface of the sea, exactly in the same manner as Captain Kotzebue describes, and at the moment we passed over it the lead was hove in a very proper manner without finding bottom; but, having lowered the boat, soundings were found to

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* It seems that the appearance of soundings described above occurs in the same place where Captain Tulloch told me a bank existed, which some Americans were in the habit of making as a fresh point of departure when bound to Surinam, &c.—A. L. But Lieut. Lee, in the *Dolphin*, found depths of 2,500 fathoms. See cruise of the *Dolphin*, pp. 101-2.

† In 1813, at the distance of 197 miles to the eastward of Barbados, we found the water discoloured; the thermometer here rose 1°. The current (Equatorial) inclines to the northward here; which, as well as the discoloured water, may be attributed to the stream discharged by the great river Orinoco, &c.—*Lieut. Evans.*

exist, although in more than 30 fathoms of water. The latitude computed from observations taken at noon, was 21° 12′ N., and long. by chronometer, 58° 12′ W.—*A. H. Bisschop Greevelink.*" (Lieut. Lee found 2,800 fathoms here.)

Off the coast of Guayana, in the morning of the 17th of September, 1835, on the track of the *Echo* from Antigua towards Surinam, there appeared at about 7 o'clock, in every direction upon the surface of the ocean, several large spots of discoloured water, more or less thickly mingled as it seemed with mud. It was a fine morning; the sun rose in all its splendour, and not a single cloud was there to throw its shade upon the water, which was uncommonly smooth, although the ship ran 6 miles an hour; besides the water in some of the spots was so thick as to make the blue waves curl against their edges. Having, says M. Greevelink, the watch at the time, I gave warning of this strange occurrence to our captain (the late and much lamented W. H. van Voss), who came on deck and ordered me to keep—not to alter—our course, by which we passed through one of those spots, yet we did not heave the lead, as it was the first day in which we gained a breeze after fourteen days struggling with horrible calm and rainy weather, and two-thirds of our crew confined to their hammocks.

While in the midst of these spots I observed the latitude by the moon, then passing the meridian 11° 47′, and the longitude by chronometers, and at the same time by lunar distances, three excellent sets, 53° 47′. In about three-quarters of an hour we were clear of them, and the sea resumed its former clearness. The current, equatorial, for several days remained northerly, yet was not very strong. (Lieut. Lee found no bottom at 2,780 fathoms.)

That we had not been in soundings we felt nearly convinced by existing circumstances; yet how came this muddy water here? The common discoloured water of Barbados it was not, as the latter is a large extent of water of a different but somewhat lighter hue than that of the ocean, at least so far as we have seen it. As for my humble opinion, I seek for a cause of this appearance only in the force with which the Marañon rushes downward, but without sufficient power to strengthen the equatorial current. This may seem contradictory, but I think it may be found reconcileable in the manner following:—

This river impetuously pours forth its waters in a mass over a bed of some declivity, which steepens more and more towards its issue till it becomes a precipice, so as to form a cataract, whereby a part of its stream may dive beneath the stratum of undulations of the ocean, and afterward rise to the surface by its lesser specific gravity; where, driven still further off by the northerly current, it may easily remain for some days in the above-mentioned manner, especially in those months wherein continual calms prevail, and the water is rarely disturbed by the wind. (This may be the case, but it may also be attributed to a volcanic origin, as stated above.)

The commander of H.M. (Netherlands) brig *Koerier* informed Capt. Stort that in the month of May, 1854, when between lats. 16° and 17° N., and in long. 54° W., he sailed for a whole day in dark coloured water. This was particularly remarked, inasmuch as similarly coloured sea is met with in

about 10° and more easterly. Purdy, in his "Atlantic Memoir," mentions that in lat. 16° N. white-coloured water has been observed.*

With this knowledge and the announcements before given of the *Betsy's Rock, Galissioniere's Rock, Martin's Reef, St. Esprit Reef*, and the singular phenomena related by Churruca, Greevelink, and Nockells, it may be inferred that a large extent of ocean, running parallel with the range of the Windward Islands, covers either a range of submarine volcanoes, or that the bed is in a state of action from the same cause.

Lieut. Lee, in the U.S. brig *Dolphin*, also met with discoloured water in lat. 12° 22′ N., long. 54° to 55° W., but found no bottom at the East end of this with 1,000 fathoms, and a depth of 2,570 fathoms at its West end.

He again came into discoloured water in lat. 14° 10′ to 14° 50′ N., long. 54° 30′ to 55° 0′.

The whaler *Sheffield*, Captain Green, April 26th, 1859, in lat. 29° 55′ N., long. 60° 10′, experienced three severe shocks of an earthquake, between 4^h 25^m and 6^h 10^m a.m. The officer on duty reported that the sea for some time previously had presented the appearance of a tide rip; the noise might be compared to that of a heavily loaded cart or waggon, drawn rapidly over a plank road.

Captain Nockells, in the ship *Brightman*, of London, 5th of May, 1835, observing that the sea appeared of a dirty dark green, in lat. 41°, long. 39° 19′, by chronometer, tried for soundings, but found no bottom at 240 fathoms.

Captain Nockells, in two previous voyages, found the water in the same place very much discoloured, which he supposed might originate from the melting of the ice in the northern latitudes.

A remarkable change in the colour of the sea was observed by M. Dupetit Thouars, on board the French frigate *La Venus*, in lat. 21° 50′, long. 19° 34′ W., in the same spot which Fraisier had already pointed out. The officers thought it was a bank, but no bottom was found with 550 fathoms.†

In the region (10° S. to 20° N. and 10° to 40° W.) for which the logs have been examined in acquiring a knowledge of the Best Route across the Equator by the Meteorological Office, the following information has been gained. It may be remarked that the logs were chiefly collected by the late Admiral FitzRoy, between the years 1855 and 1870.

Between 10° *and* 20° *N.* (squares 38, 39, 40, see diagram, page 466).—June. 17° 30′ N., 25° 30′ W., N.W. of Cape Verdes, "Passed through several streams of small particles of a *deep red colour*, apparently whale food."

September. 16° N. 21° W., 100 miles East of Cape Verde Islands (1865), "A long, continuous *straw-coloured streak* of matter in the water. When seen under the microscope it looked like bundles of fibres stuck together with some glutinous matter, which released its hold after they had been kept some time in a tumbler, and allowed the fibres to fall apart." Another remarks (1856), 10° N. 27° W., "*Much yellow matter* on the surface of the

* Verhand. en Berigten, Amsterdam, 1854, p. 385.

† Voyage de la Venus, vol. iii., p. 446.

water, parts of which, when seen through the microscope, looked like longitudinal cells or tubes of vegetable matter placed side by side, as in the Pandean Pipes. They were transparent, and rounded off at their ends."

October (1870). In 12° N. 26° W., "Sea covered with stuff looking like *Cowhage*. When viewed through a magnifying glass it appeared very much like a fid, sharp-pointed at one end, rounded off at the butt, and of various sizes, the largest about 1-16th of an inch."

December (1851). In 19° 57′ N. 19° 19′ W., "Light N.N.E. breeze; water still discoloured. Have seen two cuttle-fish to-day, and much weed, not unlike *grass*, in the water. On examination it looked like grass which grows in fresh water, and has been attached at the root to rock or soil, from which it appears to have been broken very recently. Current South, 20 miles daily for the last three days." (1855.) Eastward of Cape Verdes, "Quantities of *fish spawn* on the surface of the sea, of a brown colour." (1860.) In 20° N. 34° W., "The sea is covered with a *yellow substance*, apparently like dust. Cannot see its extent North and South. It is about 7 or 8 miles S.W. and N.E. Many dolphins and a few flying fish seen. Wind S.S.E., force 2.

Gulf weed.—Numerous instances of gulf weed observations are recorded, especially between 30° and 40° W. and 18° to 20° N. It was also observed, less frequently, between 15° and 18° N. and 20° to 30° W. In July (1 obs.) and November (1 obs.) in 12° N. 25° W. In January (1 obs.) and April (1 obs.), 150 miles S.W. of Cape Verde, in which position it must have been placed by the North African Current, as must also the following:—8° N. 16° W. (1862), "A quantity of weed floating about; it proved to be *fucus natans*, covered with a green weed."

Between the Equator and 10° *N.* (squares 2, 3, and 4) all fish (and their food), excepting *Bonitos* and *Flying Fish*, were very much confined to the part of the squares where the two trades meet.

March (1858). In 1° N. 20° W., "Passed patches of *spawn*;" 8° N. 30° W., "Passed close to an immense *turtle*;" 4° N. 20° W., "Patches of spawn, having the appearance of *white froth*."* In 3° N. 24° W., "Caught a number of small creatures of remarkable beauty in colour."

April. In the area of warmest water, about midway between St. Paul's Rocks and Cape Verde, numerous reports of *Medusae* and *jelly fish*. In 4° N. 24° W., "The surface of the sea covered with a *brownish dust*, the specks being from 1-20th to 1-30th of an inch long;" in 3° N. 20° W., "Much *fish spawn* (?) in the last twenty-four hours." In 1° N. 21° W., "Water *very dirty*, with substance like blanket hairs; when looked at through a microscope it appeared like fine seaweed, covered with coral excrescences; also a kind of minute burr, which, when magnified, was star-shaped, the radii being extremely fine.

May. *Medusae* were seen between 5° and 8° N. and about 19° to 22° W. *Animalcules*, 3° N. 31° W., and in 5° N. 35° W. In square 3, numerous observations of jelly fish, &c.

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* The float of the *Ianthina* presents the appearance alluded to in the above remark, as its shell is not seen from a ship's deck.

June. In 6° N. 26° W., "Passed a long line of *foam* and *brown matter*, about 2 ft. wide and at least 2 miles long, in which were many 'Portuguese men-of-war.'" In this month numerous *Mollusks* were seen in square 3, between 6° and 7° N., and a school of *Blackfish*, perhaps feeding on them.

July. In square 3, and in 6° N. 18° W., many *luminous animalcules* seen. In 6° N. 17° W., midnight, 8th, to 4 a.m., 9th June, 1870, "Water full of phosphorescence; drew a bucket, and found it full of bag-like *jelly-fish*, each about the size of a man's thumb, and covered with small points; from the end of each point the light seemed to be emitted, the largest head or point being at the closed end of the bag, and about the size and appearance of a large pearl. Preserved some in oil." In 2° N. 31° W. (1858), "Passed patches of seaweed, of a *light brown colour*."

August (1855.) In 3° N. 16° W., "Passed through great quantities of *animalcules*, in layers, from 40 to 50 yards distant; the water was luminous all round." (1864.) In 1° N. 23° W., "Large quantities of *Medusae* seen this afternoon; water exceedingly luminous after sunset." In square 3, *Medusae effulgens* and other gelatinous creatures seen.

September. In 5° N. 18° W., "Numerous *jelly fish* floating about." In lat. 3° to 6° N., long. 23° to 26° W., Sailed through a batch of "Portuguese men-of-war;" they were in a *rippling* which extended in a line East and West. No more than twenty or thirty were seen before or after. They were unusually large, bright coloured, pink and blue. This was just after we had sailed from South and S.W. winds into different weather, and just after a heavy shower of rain (ship going North). In 3° N. 23° W., some Portuguese men-of-war, large and blue, with pink-edged sails. I have never found them in the easterly currents hereabout, only in the westerly." In 6° N. 28° W., "Water appears to be full of *animalcules* of all sorts." In square 3, numerous notices of *animalcules*; and in 6° N. 24° W., "a quantity of *yellowish matter*, resembling fish spawn."

November (1856 and 1860). In the parallel a little North of Sierra Leone, *vegetable matter* (evidently from some of the rivers) was observed floating on the water as far West as 19° W.; seaweed was also seen (several large pieces, 1863), in 7° N. 14° W. In square 3, birds, fish, and their *food*, seem to have abounded between 4° and 5° N., where the easterly and westerly currents meet.

December. In 7° N. 22° W., "several pieces of *greenish seaweed*." In 6° N. 21° W., noon, "Passed a *large tree*, evidently torn up by the roots. It appeared about 40 ft. in length." In 3° N. 22° W., a large stream of something like *dirty oil* or *grease* floating on the water. In 8° N. 27° W., "Numerous *mollusks* floating past, in shape and size like a mushroom."

Between the Equator and 10° *S.* (squares 301, 302, 303, see diagram, p. 466). January (1858.) In 4° S., 31° W., a strong smell of seaweed, as on a sea-beach, with plenty of weed at low water. In 6° S. 32° W., the captain says the smell came from a substance on the water resembling oil. (1868.) In 5° S. 33° W., a captain remarks the curious circumstance, which, although not directly referring to our subject, is still worth quoting. "From the observations of many others, as well as from personal experience, I mention that the birds in the vicinity of the Rocas and St. Paul's Rocks are invaria-

bly to the eastward of them, only stray ones to leeward." Off Pernambuco (1857), "Passed over a large quantity of whale-dung."

March. In 4° S. 19° W., *Medusae* and *animalcules* reported. On the Equator, in 20° W. (1860), "Passed a small piece of seaweed like *sargasso*." In 9° S. 33° W., off Pernambuco, "Passed through a narrow belt of water, having its surface covered with a thick deposit of *vegetable matter*.

April. *Jelly fish* and *medusae* have been seen (1866) in 1° S. 21° W.; (1868) in 2° S. 22° W.; and (1857) in 3° S. 27° W. Off Pernambuco to the S.E. (1866), "*Water quite thick* with the seed of seaweed (microscopical).

July. In 2° S. 15° W., *Medusae* (phosphorescent). In 5° N. 18° W., "A great number of *jelly fish* floating about in large patches."

August. In 5° S. 29° W., many snake-like *gelatinous creatures* seen. In 10° S. 31° W., "Water full of *animalcules*." In 9° S. 34° W. (1860), "Much *seaweed* about, leaf oblong, with prickly point like holly, yellow colour, berries upon it single, not in clusters. Little crabs and fish amongst it in great abundance." A sketch is given in the log, which resembles *Sargasso weed*; also sketches of the crabs, &c.

September. In 4° S. 15° W., "A *mass of scum* travelling with the wind; it had a brownish appearance." Similar colouring matter was noticed in 6° S. 17° W. over a quarter of a mile of the sea, in streaks, at short distances apart.

December. On the Equator, 20° W. (1860), "Passed through a long *streak of foam*, extending N.W. and S.E. as far as the eye could reach."

DEPTH, TEMPERATURE, ETC., OF THE NORTH ATLANTIC OCEAN.

Sounding.—It was formerly considered that the lower bed of ocean-water was, from the pressure and weight of the incumbent masses, so dense as to be rather of the nature of solid matter than the natural fluid. However, a few facts will serve to dispel such a notion. The descent of the deep-sea lead is quite as rapid at a depth when the upper weight must be enormous, as at less distance from the surface, and no tendency to obstruct its downward passage can be observed at the greatest depth yet attained, except that which is due to the friction of the sounding-line. Again, the whale fishers frequently find their prey to descend perpendicularly to such an enormous depth, that the idea of an impenetrable density, or even of any considerable increase of it, cannot be for a moment entertained.

It is true that the pressure increases with the depth, to the amount of 15 lbs. upon the square inch for every 34 ft. in depth; but the density is not thereby sensibly increased, owing to the incompressibility of water; so that neither the buoyant force, nor the resistance to the motion of any body, are materially increased from the surface to the bottom. At the depth of 3,000 fathoms, for instance, the pressure upon a square inch is nearly 8,000 lbs., but the column of water of 18,000 ft. is only shortened about 160 ft.

At 2½ miles depth the increase of *density* is not equal to the difference in the density between fresh and salt water. The late Dr. W. A. Miller calculated it would be at that depth equal to one-forty-seventh of its volume, while sea-water, at the mean specific gravity of 1·027, is one-thirty-seventh heavier than fresh water. There is, therefore, not the slightest difficulty in understanding that the sounding-lead or telegraph-cable should sink uniformly from the surface to the greatest depths, and not only such heavy weights, but even that the delicate organisms and remains of microscopic animals which have lived on the surface, may quietly sink to the bottom, and there add to the immense deposits which are now shown to exist everywhere over the sea-bed.

Among the earliest experiments, perhaps the first, of these deep-sea soundings, is that recorded by Captain (now General) Edward Sabine, who, on November 13th, 1822, when about midway between the Caymans and Cape Antonio, in the Caribbean Sea, sunk a cylinder and obtained the temperature at a depth exceeding 1,000 fathoms. This was followed by Captain Wauchope, in H.M.S. *Eurydice*, who gained water from a depth of about 1,300 fathoms. After that, Captain (afterward Admiral Sir Francis) Beaufort thought that he attained a depth nearly the same in the Strait of Gibraltar; but his sounding is shown to be fallacious.

After this many experiments were tried with more or less success, but there can be little doubt but that many of the early results are not trustworthy, and are greatly in excess of the truth. At first it was not always tried to recover the lead, and the line employed was of very inferior character; and it was thought that at very great depths the friction of the water on these great lengths was sufficient entirely to arrest the descent of the weight.

On August 8th, 1848, Capt. Barnett, R.N., when between the Azores and Newfoundland, tried a line of *iron wire*, varying in size from Nos. 1 to 5, 4,000 fathoms in length, wound on a small reel, the smallest part first, with a weight attached of 61 lbs., but a hand-lead would have been better. It broke at 2,000 fathoms, which ran out in 20′ 53″. This experiment was suggested by Lieutenant Mooney.

But the greatest length of wire line sent down is that effected by Lieut. J. C. Walsh, in the U.S. schooner *Taney*, on November 15th, 1849, to a depth of more than 5,700 fathoms (34,200 ft., or more than 6 statute miles), without finding bottom, as was supposed, in lat. 31° 59′ N., long. 58° 43′ W. The wire broke at this length, 5,700 fathoms, at the reel, and was lost. It preserved the exact plumb-line throughout the sounding; there was a steady, uniform increase of weight and tension; no check whatever any instant of its descent. This experiment, however, is of a negative character; for it is evident that the wire would be carried down and run out by its own weight.

One of the earliest specimens of bottom obtained at great depths was by Comm. C. H. Davis, U.S.N., in October, 1845, when greenish mud was brought up in the Stellwagen cup from a depth of 1,350 fathoms in the Gulf Stream.

The possibility of obtaining a knowledge of the great depth of the ocean

being established, the Government of the United States first commenced utilising this knowledge, on a more extended scale, by the expedition of the brig *Dolphin*, in her well-known cruise, under the command of Lieutenant-commanding Lee, U.S.N. The result of this voyage was the disproof of many of those shoals and dangers which had long held a place on our charts, to the continual annoyance and embarrassment of navigation. These have been recited in the previous pages. This cruise of the *Dolphin* was confined to the North Atlantic, except a portion in South latitude about Fernando Noronha, and the Rocas. The *Dolphin* was again sent out under the command of Lieut. O. H. Berryman, with the same object.

The soundings taken in the *Dolphin*, most of which will be given presently, were taken with the thin sounding line, seven-hundredths of an inch in diameter, and one or two 32 lb. shot. It has been questioned, and it certainly seems with reason, whether the evidence upon which the deeper soundings rest is quite valid, as has been before alluded to.

There are two methods of estimating the true depth obtained, the one by the rate of descent of the line, which has been carefully estimated from the numerous experiments made, but which estimate, of course, is liable to the vitiating influence of under-currents. In sounding with a line of seven-hundredths of an inch in diameter, the velocities of the descent diminish, with one 32 lb. shot, from 8·83 feet per second at 50 fathoms, to 2·84 feet at 1,000, and 2·09 ft. at 2,000 fathoms; and with two 32 lb. shot, from 12·5 feet per second at 50 fathoms, to 3·48 feet at 1,000, or 2·99 feet at 2,000 fathoms; but these figures have been much modified by later experience.

Another very important consideration is—what effect would under-currents have on the line in passing through it?

It is certain that a current must act upon the *bight* of the sounding line after the weight has passed through it, and it may operate in swerving the weight itself from its perpendicular descent at great depths. Again, the force exerted by a current against the *bight* of the sounding line will have the effect of taking the twine off the reel at nearly *double* its own velocity.

From these considerations it was supposed that the depths stated, even when it is certain that the bottom has been reached, are in excess, and this, too, in an uncertain degree. But this source of error was much over estimated. At that time there was no experience by which a knowledge would be acquired as to the movements of the water at any considerable depth. But it is now well ascertained that any movement which would greatly affect the registered depth ceases at a comparatively short depth below the surface, and that, although the lower strata of ocean waters must have some circulatory movement, this motion is so slow as to be inappreciable by any means hitherto applied to estimate it on the open ocean. In laying the various telegraph cables across the Atlantic the strain it exerts is most carefully and continuously watched by its action on a dynamometer, and the angle it makes with the surface of the sea also well looked at, and these evidences accord so nearly with the calculations that would be made for water in a quiescent state that it is now beyond controversy, that rapid motion is confined to the upper strata.

To obviate these sources of error or doubt, a line of fine sewing silk has been proposed, but we have not heard of any trial with this.

Previous to the deep-sea soundings obtained during the cruise of H.M.S. *Challenger*, the most important, and probably the most accurate, soundings that had yet been taken, were those which originated in the question of connecting Europe with America by the submarine electric telegraph. The first of these series was obtained by Lieutenant-Commanding O. H. Berryman, in the U.S. steamer *Arctic*, in August, 1856. The line of deep sea soundings, 24 in number, being on the great circle joining Valentia, Ireland, with St. John's, Newfoundland. The depths were estimated by a machine, Massey's Sounding Machine, and a similar one by M. Lecointre, and the line was wound in by a small engine on the deck.

The same round was gone over with the same object, by Lieutenant-Commanding James Dayman, R.N., in H.M.S. *Cyclops*, in June and July, 1857, and 34 soundings were obtained, the depths being estimated by the length of line and by the machine as heretofore. The sinker employed was self-detaching upon touching the bottom, and in a quill attached to the support, bottom was brought up in almost every instance in small quantities. The nature of this bottom is alluded to hereafter, and the very interesting features it first brought to light are there related.

The first failure of the Atlantic Cable having suggested the necessity of shorter sea sections of the cable, Commander Dayman was despatched in H.M.S. *Gorgon*, in September and October, 1858, and obtained soundings between Newfoundland, the Azores, and England, gaining much experience as to the best methods of sounding, and also of estimating the depths.

Another project for the telegraph cable, to pursue a more northern route, having arisen, in July, 1860, H.M.S. *Bulldog* started under the command of Captain Sir Leopold M'Clintock, of Arctic celebrity, and obtained the depths between the Færoe Islands and Iceland, and thence to Greenland and Labrador, with most satisfactory results.

The apparatus used in ascertaining the depth and obtaining specimens of the bottom has been gradually modified to obviate the difficulties that have been encountered. These chiefly refer to the means of detaching the sounding weights and in the form of the apparatus which secures a portion of the bottom when it is attained. At first a peculiar pair of clams or hooks, the invention of Mr. Bonnici, were used. The weight or spherical shot was suspended to these hooks, and when it touched the bottom these hooks detached themselves and let the weight free. This in various forms was used in the earlier experiments. But when the *Bulldog* was equipped, another description of sinker and scoop were used.

The soundings were obtained generally by cod-line, with an iron sinker of 118 lbs., the line and sinker being lost at each sounding. The depth being thus obtained, a machine for bringing up the bottom was next sent down by a stronger line, and a self-detaching tubular weight or sinker of 100 lbs. The apparatus which brought up specimens of the bott m was a double scoop, 5 inches in diameter, kept open so long as the weight is dependent on it, but forcibly closed by means of a vulcanised india-rubber band the moment it is detached by touching the bottom. This brought up specimens

in large quantities. It was contrived by Dr. Wallich and Mr. Steil, the assistant engineer, and has been called the Bulldog Machine.*

The subject of the Atlantic Telegraph being still of great importance, and it being desirable that the apparent sudden dip from 550 to 1,750 fathoms on the parallel of 52° 15′ N., at about 170 miles West of Valentia found by Captain Dayman in 1857, should be avoided, H.M.S. *Porcupine* was despatched in June, 1862, to make a further examination. Mr. Hoskyn, R.N., has made a very careful examination of the edge of the bank of soundings between the parallels of 51° and 54°, as well as of that between Iceland and Rockall. It will be needless to recapitulate this work—the charts are by far the best guide; but it may be said that no such sudden dip or abrupt precipice was found, the steepest incline being a difference of level of 3,060 ft. in $2\frac{3}{4}$ miles, or about 19 ft. in 100 ft.

One important result of this expedition was the discovery of the unsuspected bank, least depth found 82 fathoms, which lies 120 miles West of Galway Bay, and has been named the *Porcupine Bank*. This bank is about 40 miles in extent, with 150 to 180 fathoms to the eastward of it, while to the westward it deepens rapidly to 300, 500, and 1,500 fathoms.

Several other expeditions were afterwards organised with a view to obtaining an exact knowledge of the nature of the sea-bed and of the depth of the ocean. The voyage of H.M.S. *Hydra*, Capt. P. R. Shortland, R.N., and that of the *Lightning*,† in 1868, under Dr. Carpenter and Dr. Wyville Thompson, may be cited as the most prominent.

In 1869, H.M.S. *Porcupine* was sent out to continue these interesting researches, and under the masterly seamanship of her Commander Captain Calver, R.N., the apparatus used was brought much more nearly to perfection.

As it was considered advisable by Capt. Calver that provision should be made for carrying on sounding and dredging at either end of the ship, a "derrick" with an "accumulator"‡ was rigged out both at the bow and the stern.

An ample supply of sounding-line was provided, specially manufactured for the purpose; this line, made of the best Italian hemp, although no more than 0·8 inch in circumference, bears a strain of 12 cwt.

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* The full particulars of this machine, and of the whole subject of deep-sea sounding, is to be found in Dr. Wallich's excellent work on the Atlantic Sea Bed.

† Dr. Carpenter says H.M.S. *Lightning* has a further historical interest, as one of the *first two* steam-vessels built in 1825 for the Royal Navy.

‡ The accumulator is composed of a number of strong vulcanized india-rubber springs combined at their extremities; and its use is two-fold,—*first*, to indicate by its elongation any excessive strain upon the sounding or dredging line, which passes through the block; and *second*, to ease off the suddenness of such strain, and give time for the action by which it may be relieved. This is specially valuable in deep-sea sounding and dredging when the vessel is pitching; for the friction of two or three miles of immersed line is so great as to prevent its yielding to any sudden jerk, such as that given to its attached extremity by a vertical motion of a few feet when the vessel rises to a sea. And it is absolutely needful when dredging is carried on from a vessel as large as the *Porcupine;* since, whenever the dredge fouls, the momentum of such a vessel, however slowly it might be moving through the water, would cause the dredge-line to part, if the strain were sudden instead of gradual.

For the deeper soundings, the *Hydra* Apparatus was employed. The essential principle of this is the same with that of all the other forms of deep-sea sounding apparatus now in use; the weights or sinkers being so attached as to be let go by a mechanical contrivance when it touches the bottom, so that the line is relieved from the duty of raising them to the surface,—the rod or tube alone, with the water-bottle and thermometers, being brought up by it. For soundings at depths of from 1,000 to 1,500 fathoms, *two* sinkers, each of 112 lbs., were employed; and for yet deeper soundings *three* were used. The peculiarity of the *Hydra* Apparatus consists partly in the mechanical contrivance for the detachment of the sinkers; and partly in the construction of the rod which carries them, this being a strong tube furnished with valves that open upwards, so as to allow the water to stream through it freely in its descent, whilst they enclose the mud or sand into which the tube is forced on striking the bottom before the sinker is detached.

The important results of this expedition in the seas N.W. of the British Isles will be briefly alluded to presently, but the topic is too wide for full notice here.*

The most extensive deep-sea exploring expedition was conducted on board H.M.S. *Challenger*, between December, 1872, and May, 1876, a period of three years and five months, three years of which time was spent between 40° N. and 40° S. of the equator. Elaborate investigations were made in each of the great oceans of the globe, and it may be interesting to record that during this lengthened voyage the ship sailed and steamed over upwards of 68,000 miles, that nearly 400 deep soundings were taken, of which two were over 4,000 fathoms, nine between 3,000 and 4,000 fathoms, 168 between 2,000 and 3,000, 124 between 1,000 and 2,000, the remainder being under 1,000 fathoms. There were 360 observing stations established, at each of which, as far as circumstances would permit, the exact depth was determined; samples of the bottom from 1 oz. to 1 lb. were obtained; samples of water from the bottom and from various depths were procured for physical and chemical examination; the bottom and intermediate temperatures were determined; at most stations a fair sample of the bottom *fauna*, and of that of intermediate depths was obtained by the dredge or trawl variously adjusted; atmospheric and meteorological observations were made; the direction and rate of the surface (and in one or two cases of sub-surface) currents were determined. For deep-sea sounding a modification of the *Hydra* machine was used, the invention of Lieut. C.W. Baillie, R.N.; many improvements in the means of obtaining water for analysis from great depths were also brought into use, including the "slip water bottle" and Buchanan's "Stop-cock water bottle" (named after J. Y. Buchanan, M.A., the chemist of the scientific staff). Some results of the expedition will be given hereafter relating to the North Atlantic, in which 130 soundings were taken and other observations made (Dec. 30th, 1872, to Aug. 30th, 1873), between Portsmouth and Tenerife, Tenerife and St. Thomas in the Caribbees, St. Thomas and Bermudas, Bermudas and Halifax, having crossed the Gulf

* See Proceedings of the Royal Society, vol. xviii., No. 181, for a full report of the voyage.

Stream in a north-westerly direction, Halifax and Bermudas, Bermudas and Madeira, Madeira and Bahia, crossing the eastern portion of the Guinea current in a Southerly direction. On the return voyage in 1876, crossing the Equator in about 14° 25′ W., on April 7th, Spithead was reached on 24th of May. The work of Sir Wyville Thomson* will supply further particulars.

Depth.—For a comprehensive view of this subject we must refer the reader to the illustrative diagram, as a verbal account of the depths obtained in these and other voyages would convey but little intelligible information.

The form of the sea-bed of the Atlantic Ocean (North and South) is thus described by Sir Wyville Thomson :†—

" Combining our own observations with reliable data which have been previously or subsequently acquired, we find that the mean depth of the Atlantic is a little over 2,000 fathoms. An elevated ridge, rising to an average height of about 1,900 fathoms below the surface, traverses the basins of the North and South Atlantic in a meridional direction from Cape Farewell, probably as far South at least as Gough Island, following roughly the outlines of the coasts of the Old and New Worlds.

A branch of this elevation strikes off to the south-westward about the parallel of 10° N., and connects it with the coast of South America at Cape Orange, and another branch crosses the eastern trough, joining the continent of Africa probably about the parallel of 25° S. The Atlantic Ocean is thus divided by the axial ridge and its branches into three basins : an eastern, which extends from the West of Ireland nearly to the Cape of Good Hope, with an average depth along the middle line of 2,500 fathoms ; a north-western basin, occupying the great eastern bight of the American continent, with an average depth of 3,000 fathoms ; and a gulf running up the coast of South America as far as Cape Orange, and open to the southward, with a mean depth of 3,000 fathoms."

Of course the question does not affect navigation, however interesting it may be to the physical geographer, and therefore we give the principal results of the *earlier* soundings in a tabular form, premising that many of them are now open to much doubt, since more improved methods of obtaining the depth have shown some formerly unsuspected fallacies. Still they cannot be cast on one side, and therefore they are here repeated.

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* Voyage of the *Challenger*.—The Atlantic.—2 vols. Macmillan, 1877.

† Voyage of the *Challenger*, vol. ii., pp. 290—291.

NORTH
ATLANTIC OCEAN
BOTTOM CHART
Submarine Telegraph Cables thus
Fathoms 1 Nautic Mile
HUDSONS BAY
GREENLAND
ICELAND
Faroe Is
Shetlands
Orkneys
NORTH SEA
NORWAY
SCOTLAND
IRELAND
FRANCE
PARIS
BAY of BISCAY
SPAIN
MEDITERRANEAN SEA
Azores
Canary Is
C Verde Isles
AFRICA
UNITED STATES
CANADA
LABRADOR
NEWFOUNDLAND
Bermudas
GULF of MEXICO
CARIBBEAN SEA
ANTILLES
PACIFIC OCEAN
SOUTH AMERICA
Equator
Tropic of Cancer
Southampton 14
Hudson Str
DAVIS STRAIT
Under 1000
1000 1500
1500 2000
2000 2500
2500 3000
3000 3500
3500 4000
4000 4500
4500 5000
5000 5500
Over 5500
Fathoms

SOUNDINGS.

BETWEEN LATITUDES 40° AND 50° N.

Lat. N. ° ′	Long. W. ° ′	Depth. Fathoms.	Lat. N. ° ′	Long. W. ° ′	Depth. Fathoms.
47 12	10 0	2525 *a*	45 58	29 35	1900 *d*
46 42	13 5	● 1500 *b*	49 59	17 35	2700 ..
46 12	13 3	1800 ..	49 57	13 16	1580 ..
40 24	25 25	1200 *c*	47 38	9 1	1800 ..
41 4	24 31	2000 ..	46 32	12 42	2190 ..
41 50	23 40	1900 ..	44 5	13 29	2560 ..
42 16	22 32	1885 ..	42 7	15 29	2500 ..
43 17	21 20	1800 ..	40 20	17 48	2650 ..
44 5	20 0	2100 ..	42 10	42 4	1850 ..
44 34	18 47	2374 ..	46 53	37 46	2000 ..
45 11	17 26	2100 ..	48 16	35 22	2100 ..
45 53	16 7	2300 ..	49 53	31 34	1900 ..
46 33	14 39	2405 ..	43 10	46 56	2760 *e*
47 6	12 57	2350 ..	42 24	43 19	2725 ..
47 48	11 12	2275 ..	42 7	41 28	● 3000 ..
46 48	21 42	2165 *d*	40 10	35 2	2775 ..
44 42	24 35	1500 ..	40 34	58 30	2750 *d*
44 43	24 35	1370 ..	41 7	54 37	2710 ..
43 47	24 24	1850 ..	41 43	51 31	3130 ..
45 7	26 8	1500 ..	42 22	50 0	1650 ..
46 26	26 55	1400 ..	41 9	43 40	1975 ..
45 13	27 38	1320 ..	40 50	64 44	2200 ..
42 44	28 20	1210 ..	41 12	62 38	2200 ..
40 49	29 0	1080 ..	41 40	59 23	2600 ..
40 48	30 2	830 ..	41 40	56 1	2595 ..
40 35	31 56	1230 ..	40 36	54 18	3450 ..
42 40	31 11	1680 ..	41 7	49 23	4580 ..
44 52	30 38	1560 ..	43 40	42 55	2700 ..
46 15	30 4	1760 ..	44 41	40 16	1800 ..

BETWEEN LATITUDES 30° AND 40° N.

33 8	16 10	● 2950 *d*	39 40	33 34	1925 *c*
34 18	16 45	2298 ..	39 12	32 32	1075 ..
36 59	19 58	2500 ..	38 54	31 2	925 ..
36 49	19 54	2750 ..	38 33	29 33	960 ..
30 49	27 25	● 1100 ..	38 23	28 50	409 ..
30 49	27 25	● 2200 ..	38 51	28 27	766 ..
39 14	19 1	2820 ..	39 17	27 46	805 ..
34 23	20 57	2150 ..	39 41	26 37	1425 ..
31 46	22 3	2850 ..	38 54	33 30	1500 *d*
37 50	32 7	2000 *e*	31 17	33 8	2400 ..
36 0	27 20	● 4000 ..	39 36	41 6	2675 ..
35 6	26 50	● 4000 ..	33 35	38 32	1800 *f*

● *No Bottom.*
a Soundings taken by Commander Dayman, in H.M.S. *Cyclops.*
b „ „ Captain Pullen, in H.M.S. *Cyclops*, 1858.
c „ „ Commander Dayman, in H.M.S. *Gorgon*, 1858.
d „ „ Lieutenant O. H. Berryman, U.S. brig *Dolphin.*
e „ taken in U.S.S. *Jamestown.*
f „ „ U.S.S. *Susquehanna.*

BETWEEN LATITUDES 30° AND 40° N.—(*Continued.*)

Lat. N. ° ′	Long. W. ° ′	Depth. Fathoms.	Lat. N. ° ′	Long. W. ° ′	Depth. Fathoms.
36 16	46 52	● 5070 *g*	32 46	59 56	● 800 ..
34 11	43 21	2800 *h*	32 10	59 9	● 300 ..
38 15	45 33	2000 *e*	31 17	53 22	● 500 ..
38 50	43 49	1600 ?	38 38	66 31	● 1625 *k*
31 16	43 28	2080 *d*	33 34	61 38	● 1950 ..
32 1	44 21	2250 ..	30 5	58 52	● 1000 ..
32 29	47 2	● 1950 ..	37 24	68 52	2920 *d*
32 55	47 58	● 6600 ..	38 3	67 14	● 4920 ..
33 3	48 36	3550 ..	36 43	74 0	● 1500 *e*
32 47	50 0	3250 ..	36 33	73 0	● 1900 ..
33 50	52 34	2600 *i*	37 6	68 2	2000 ..
32 6	44 47	5500 ?..	38 13	62 32	3700 ..
31 1	44 31	2300 ..	39 39	70 30	● 1000 *d*
35 7	25 43	1040 ..	30 38	70 10	● 600 *j*
37 28	56 22	5000 ? *h*	33 3	72 14	● 345 ..
37 26	65 48	● 1175 *j*	34 2	73 6	● 700 ..
35 52	65 56	● 1000 ..	36 4	73 59	● 1460 ..

BETWEEN LATITUDES 20° AND 30° N.

			18 32	49 48	2370 ..
29 12	22 50	2810 *d*	21 26	51 31	2300 ..
23 58	24 20	2700 ..	22 27	53 15	2390 ..
21 6	24 38	2625 ..	21 45	55 46	2800 ..
10 0	27 30	2000 *l*	12 9	55 17	2435 *n*
4 16	21 42	2700 ..	20 51	58 26	2800 *d*
2 20	28 44	1080 ..	20 2	61 2	2810 ..
27 5	21 21	1700 *d*	21 19	66 27	2960 ..
27 2	30 48	2580 ..	23 42	67 37	2940 ..
20 2	31 6	2560 ..	29 26	56 42	1480 ..
21 48	32 36	7020 ?..	28 20	59 44	2900 ..
20 29	34 18	2850 ..	28 4	61 44	3080 ..
26 43	38 39	● 800 *j*	28 23	64 17	2518 ..
25 30	37 44	1720 ..	26 49	66 54	2710 ..
25 30	37 42	● 1560 ..	28 14	69 24	2950 ..
25 4	36 13	● 1000 ..	20 12	59 39	● 1200 *j*
23 43	32 39	● 2180 ..	22 39	59 26	● 800 ..
23 41	32 39	● 2200 ..	23 1	59 26	● 358 ..
23 15	32 24	● 2200 ..	23 36	59 25	● 600 ..
21 19	38 10	4700 *m*	24 37	59 49	● 534 ..
28 55	41 21	● 1880 *d*	25 11	60 0	● 520 ..
29 14	35 49	2270 ..	25 45	60 7	● 556 ..
21 6	42 9	2370 ..	26 32	60 7	3825 ..
23 6	44 0	1760 ..	24 11	61 44	3450 ..
21 18	46 14	1875 ..	24 27	62 55	● 450 ..

● *No Bottom.*

d Soundings taken by Lieutenant O. H. Berryman, U.S. brig *Dolphin.*
g „ „ in U.S.S. *St. Louis.*
h „ „ U.S.S. *Plymouth.*
i „ „ *John Adams.*
j „ „ by Lieut Lee in U.S. brig *Dolphin.*
k „ „ Capt. Platt, U.S. *Albany.*
l „ „ Captain Pullen, in H.M.S. *Cyclops.*
m „ „ in U.S.S. *Portsmouth.*
n „ „ U.S.S. Steamer *Saranac.*

BETWEEN LATITUDES 20° AND 30° N.—(*continued*).

Lat. N. ° ′	Long. W. ° ′	Depth. Fathoms.	Lat. N. ° ′	Long. W. ° ′	Depth. Fathoms.
24 28	63 30	● 1000 *j*	27 10	76 59	1180 *k*
24 34	65 32	● 1000 ..	27 10	75 6	1806 ..
24 37	65 12	● 3560 ..	26 31	74 10	1590 ..
25 14	66 57	● 2350 ..	26 28.	73 50	1773 ..
26 33	67 33	● 1000 ..	25 30	72 7	4100 ..
27 21	68 6	● 1600 ..	24 48	70 22	1893 ..
28 56	69 4	● 1000 ..	24 48	69 39	3600 ?
27 19	77 18	690 *k*	22 42	69 0	2762 ..

BETWEEN THE EQUATOR AND 20° N.

0 18	18 41	● 2000 *j*	17 2	28 8	2460 *d*
0 16	18 51	● 1900 ..	18 44	29 18	2520 ..
0 45	18 29	2680 ..	18 49	36 16	2820 ..
2 17	15 45	● 900 ..	19 23	40 23	2580 ..
3 1	18 36	2725 ..	0 10	38 44	● 1000 *j*
2 36	19 22	2780 ..	0 57	41 6	2980 ..
2 10	19 57	2750 ..	1 7	42 58	● 1000 ..
		2690 ..	1 7	43 44	● 2000 ..
8 43	20 52	2270 ..	0 54	44 52	● 1000 ..
7 17	20 7	2050 ..	0 43	45 1	● 1000 ..
		1940 ..	1 10	44 11	● 500 ..
5 37	19 35	● 2019 ..	0 54	43 36	● 500 ..
4 27	19 21	2540 ?	0 42	44 21	640 ..
4 5	19 15	2125 ?	7 58	47 51	1970 ..
4 14	19 20	2670 ..	10 38	47 40	● 500 ..
3 42	19 6	2760 ..	11 12	47 37	● 1855 ..
3 51	19 6	2760 ..	15 0	48 58	● 250 ..
18 39	25 24	1970 ..	15 56	49 34	● 500 ..
18 19	25 5	1675 ..	15 52	49 34	● 540 ..
18 11	23 48	1612 ..	15 56	49 39	● 500 ..
17 35	22 50	1370 ..	15 6	50 34	● 500 ..
16 30	20 58	1941 ..	14 21	51 24	● 564 ..
16 34	20 47	1875 ..	13 28	52 26	● 1960 ..
16 59	21 38	1580 ..	12 47	52 58	2710 ..
15 24	21 47	1220 ..	11 47	53 49	● 1000 ..
15 9	22 29	1380 ..	12 20	54 49	2570 ..
15 8	22 57	1120 ..	15 25	55 1	3020 ..
15 3	23 13	790 ..	15 54	56 45	● 1000 ..
14 48	23 50	● 900 ..	16 43	58 6	● 345 ..
13 1	22 59	● 680 ..	16 43	58 55	● 3200 ..
11 7	21 57	1160 ..	16 42	59 6	● 1000 ..
		1120 ..	19 2	59 33	3300 ..
18 10	24 51	2080 *d*	19 41	65 7	3875 *l*

● *No Bottom.*

d Soundings taken by Lieutenant O. H. Berryman, U.S. brig *Dolphin*.

j „ „ by Lieutenant Lee, in U.S. brig *Dolphin*.

k „ „ by Captain Platt, U.S. *Albany*.

l „ „ by H.M.S. *Challenger*, March 26th, 1873. Deepest Sounding yet obtained in Atlantic.

Temperature.—Up to the latter part of 1869, all enquiries into deep sea temperatures appear to have been alike deceptive and unsatisfactory, as the indications obtained, even by the most careful observers, and best of instruments, were utterly at variance with any theory that could associate temperature as a leading cause of the circulation of the waters of the ocean. Thus, temperatures that reason would expect to find—say 30° Fahrenheit—at great depths, were made to appear to be 42° or 43°, the disparity being less as depth diminished.*

This was caused by the elasticity of the glass bulbs yielding to the pressure of the water, though they recovered their normal condition on reaching the surface, so that the effect of this pressure still remained unknown.

It may be said that about this time most of the leading Governments had determined, if possible, to ascertain the real temperatures of the sea The efforts of the American, Russian, and German Governments in this direction are well known, whilst the authorities of our Hydrographic Office applied to the Royal Society on the subject, and at their desire, towards the end of 1869, an hydraulic machine was constructed in which to test the effect of pressure on the thermometers employed. A standard registering thermometer, shielded in a stout glass cylinder, was therefore placed in the water together with one of the deep sea thermometers, and the water was compressed to an extent equal in pressure to about 3 miles of depth in the sea. All previous suspicion of errors were now fully confirmed, as the pressure on the bulb was found to cause an error of 12° to 13° Fahrenheit at this depth.

To remedy this defect, a glass shield was suggested by Dr. W. A. Miller, then Vice-President of the Royal Society, as a protection to the bulb, and from which the well-known Miller-Casella thermometer has been named.†

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* Mr. Prestwich has collected these series of observations with a view to the geological bearing of the subject, and they will form a valuable supplement to those collected since 1868. See "Tables of Temperatures of the Sea at Various Depths below the Surface, taken between 1749 and 1868." Collated and reduced with notes and sections, by Joseph Prestwich, F.R.S., F.G.S. (from the Proceedings of the Royal Society, No. 154, 1874.)

† The following, from the proceedings of the Royal Society, No. 113, 1869, will further explain the interesting result:—

Self-Registering Thermometers adapted to Deep Sea Soundings.—"Several of these thermometers have been prepared for the purpose with unusual care by Mr. Casella, who has determined the conditions of strength in the spring and diameter of tube most favourable to accuracy. He has also himself had an hydraulic press constructed expressly with the view of testing these instruments. By means of this press the experiments hereafter to be described were made,

"The expedient adopted (as suggested by Dr. Miller) for protecting the thermometers from the effects of pressure, consisted simply in enclosing the bulb of such a Six's thermometer in a second or outer glass tube, which was fused upon the stem of the instrument in the manner shown in the illustration on page 854. This outer tube was nearly filled with alcohol, leaving a little space to allow of variation in bulk due to expansion. The spirit was heated to displace part of the air by means of its vapour, and the outer tube and its contents were sealed hermetically.

"In this way, variations in external pressure are prevented from affecting the bulb of the thermometer within, whilst changes of temperature in the surrounding medium are speedily transmitted through the thin stratum of interposed alcohol.

"Notwithstanding the great pressure to which these instruments had been subjected, all of them, without exception, recovered their original scale-readings as soon as the pressure was removed."

More full details regarding this interesting question will be found in the writings of Dr. Carpenter.*

Surface Temperature.—Speaking roughly, the mean annual surface temperature of the Atlantic, is about 75° Fahrenheit at the Equator (between 10° N. and 10° S.). Between 10° N. and 38° N. it is 70°. Northward of 38° N. the *Summer* Isotherms (lines passing through places of equal mean temperatures) of 54½°, 50°, and 45½°, turn sharply northwards to the east of the Banks of Newfoundland: diverging one from another and from the summer Isotherms of 60° at intervals which are pretty nearly equal almost as far to the East as the meridian of 30° W.; but then again trending strongly to the North, so that the summer Isotherm of 54½° crosses the parallel of 60° N. before (by a slight trend to the South) it passes through the Pentland Firth. Thence, crossing the North Sea, this Isotherm passes along the coast of Norway as far as Tromsö (very near the parallel of 70°), and then turns southwards along the land, keeping within the coast-line of Russian Lapland, and passing across the narrow throat of the White Sea. Still further North we find the summer Isotherms of 41° and 36½° showing a nearly W. to E. direction until they have passed the meridian of 10° W., and then suddenly turning northwards; the line of 36½° passing up to the West of Spitzbergen as far as 82° N., and also extending itself irregularly eastwards along the parallel of 75° as far as Nova Sembla.

The course of the *Winter* Isotherms of 45½°, 41, 36½, and 32°, as shown in Dr. Petermann's chart, is no less significant; for they all turn sharply to the North on the eastern side of the Banks of Newfoundland, cross the entrance of Baffin's Bay, and then keep a course of general parallelism to the coast of Greenland, crossing the meridian of 30° W. at almost equal intervals. The Winter Isotherm of 45½° follows almost exactly the course of the Summer Isotherm of 54½° as far as the Shetland Islands; but it then turns back on itself so as to form a loop, passing southwards along the Western Hebrides towards Belfast. Finally, the Winter Isotherm of 32° proceeds along a similar course from the Bank of Newfoundland to the northernmost point of Iceland, and then onwards towards Jan Mayen, beyond which it has not been traced.

In the above, it will be remarked that the surface temperature North of 40° N. is much greater on the eastern than on the western side of the Atlantic, both in summer and winter; this is due in a great measure to the prevalent south-westerly winds, blowing the warmer water in a north-easterly direction, and also, as will be hereafter explained, to the general oceanic circulation.

It is beyond the scope of this work to enter more into detail as to the

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In sea-water of specific gravity 1.027, the pressure in descending increases at the rate of 280 lbs. upon the square inch for every 100 fathoms, or exactly one ton for every 800 fathoms.

* "Further Enquiries on Oceanic Circulation." By William B. Carpenter, M.D., LL.D., F.R.S., &c., &c.—(Proceedings of the Royal Geographical Society, vol. xviii., No. iv., 1874).

"On the Temperature of the Deep-Sea Bottom, and the Conditions by which it is Determined." By Dr. Carpenter, M.D., LL.D., F.R.S., &c. — (Proceedings of the Royal Geographical Society, vol. xxi., No. iv., 1877).

power of the various surface currents is distributing heat over the ocean; but that this heated water does not extend to any great depth will be understood from the following remarks on sub-surface temperatures. We must also refer the reader to the earlier portion of this book, where in the description of the Currents, some particulars of the depth to which their warm water extends is generally given.

Sub-surface Temperature.—Taking a general view or mean for the year of the water in Mid-Atlantic, in a section taken nearly North and South we find the temperatures as follows:—

Temperature Section (North and South) of Mid-Atlantic in deg. Fahrenheit.

	60° N.	55° N.	47° N.	38° N.	22° N.	Equator.	20° S.	38° S.
At the Surface	50	57	63	70	70	75	70	54
50 fathoms	50	56	62	65	70	75	69	53
100 „	49	53	55	64	69	70	65	52
200 „	48	50	51	52	55	48	45	45
500 „	45	46	47	45	44	39	38	37
1000 „	40	38	38	37	38	38	36	36
2000 „	..	37	36	36	35	34	33	34
Bottom	..	..	..	35	35	32	33	33
Depth of bottom	800 fms.	1500 fms.	2000 fms.	2700 fms.	2700 fms.	2500 fms.	2200 fms.	2200 fms.

It may now be confidently stated as a general fact (1) that over not only the Temperate but also the Intertropical portions of the oceanic area, a bottom-temperature prevails of between 32° and 35°.5 Fahr.; whilst within the Polar areas this temperature falls to 28°. Further, it may be asserted (2) that this vast oceanic basin, whose average depth may be estimated at about *two miles and a half*, is occupied to within 400 fathoms of its surface (save in the exceptional case in the Gulf Stream region), by water whose temperature is below 40° Fahr.,—this cold water actually coming up nearer to the surface in the Equatorial Atlantic (as several of the older observers had noticed) than it does beneath the Tropics.

Were the bottom of the Atlantic a perfect basin, the bottom temperatures might hold good across its whole breadth, but, as described in page 818, and shown in the diagram, the Atlantic sea-bed is divided by ridges into several basins. Now, it has been found that, however deep a basin or depression of the sea-bed may be, yet that the temperature of its water at the bottom will not be less than that which can pass across its ridge, from outside sources. This was observed by Captain Chimmo in the Sulu Sea, a striking example, where at and below a depth of about 300 fathoms (the depth of the enclosing barrier) to the bottom, at 1,778 fathoms, the temperature remained uniform at about 50° Fahr., whereas in the China Sea the flow from the polar to the equatorial regions of cold water reduced the temperature, at a depth of 416 fathoms, to 41°, and at the bottom (1,546 fathoms to 37° Fahr.) 13° Fahr. less temperature than at the *deeper* station of the Sulu Sea. The same system holds good in such large areas of

depressed sea-bed as those in the North Atlantic, and it has been found that the bottom temperature is never below 35.3° Fahr. in the eastern basin, however deep the water may be; nor below 34.6° Fahr. in the north-western. The only place on the Atlantic sea-bed where the water has been found below 32° (freezing point of fresh water) in the Temperate or Tropical regions, is in the depression between the coast of South America and the central ridge to the South of the Equator. In conclusion, it may be remarked, that these deep-sea temperature soundings have been of great practical utility to telegraph engineers in regulating the size of the wire, &c., in deep-sea cables, and they will be alluded to presently as affecting the question of Circulation.

Saltness and Density.—A very interesting essay on the first of these topics was laid before the Royal Society in 1865, by Professor Georgo Forchhammer, of the University, and Director of the Polytechnic Institute, at Copenhagen.* We can only make a few extracts from it.

"The elements which occur in the greatest quantity in sea-water have been long known, and chlorine, sulphuric acid, soda, magnesia, and lime, have, for more than a century past, been considered as its essential parts. In our century, iodine, bromine, potash, silica, phosphoric acid, and iron, have been discovered in sea-water, and the latest enquiries, my own included, have brought the number of elements occurring in sea-water up to twenty-seven.

"They are: 1, oxygen; 2, hydrogen; 3, chlorine; 4, bromine; 5, iodine; 6, fluorine; 7, sulphur; 8, phosphorus; 9, nitrogen; 10, carbon; 11, silicium; 12, boron; 13, silver; 14, copper; 15, lead; 16, zinc; 17, cobalt; 18, nickle; 19, iron; 20, manganese; 21, aluminium; 22, magnesium; 23, calcium; 24, strontium; 25, baryta; 26, sodium; 27, potassium.

"The next question to be considered refers to the proportion between all the salts together and the water; or, to express it in one word, I may allow myself to call it the salinity of the sea-water, and in connection with this salinity or strength, the proportion of the different solid constituent parts among themselves. On comparing the older chemical analyses of sea-water we should be led to suppose that the water in the different seas had, besides its salinity, its own peculiar character expressed by the different proportions of its most prevalent acids and bases, but the following researches will show that this difference is very trifling in the ocean, and has a more decided character only near the shores, in the bays of the sea, and at the mouth of great rivers, wherever the influence of the land is prevailing.

I have always calculated the single substances and the whole quantity of salt for 1,000 parts of sea-water; but besides this I have calculated the proportion between the different substances determined, referred to chlorine = 100, and of all the salts likewise referred to chlorine. This last number is found, if we divide the sum of all the salts found in 1,000 parts of any sea-water, by the quantity of chlorine found in it, and I call it the co-efficient of that sample of sea-water. The following remarks will show that there is a very small difference in the co-efficient of the different parts of

* On the Composition of Sea-water on different parts of the Ocean.—"Philosophical Transactions of the Royal Society of London," 1865, part 1, pp. 203 *et seq.*

the ocean, but that the differences become striking in the neighbourhood of the shores.

Without pursuing the subject into the details given by Professor Forchammer, we extract the following as the general results of his investigations:—

If we excepth the North Sea, the Kattegat, Sound, and Baltic, the Mediterranean and Black Seas, the Caribbean and the Red Seas, which have all the characters of bays of the great ocean, the mean numbers are the following:—

Sea water.	Chlorine.	Sulphuric acid.	Lime.	Magnesia.	All salts.	Co-efficient.
1.000	18.999	2.258	0.556	2.096	34.404	1.812
	100.	11.88	2.93	11.03		
Equivalents	429.	45.	16.	82.		

Thus it is evident that sea-water in its totality is as little a chemical compound as the atmospheric air; that it is composed of solutions of different chemical compounds; that it is neutral, because it everywhere in the atmosphere finds carbonic acid to neutralize its bases, and everywhere on its bottom and shores finds carbonate of lime to neutralize any prevailing strong acid; that, lastly, the great stability of its composition depends upon its enormous mass and its constant motion, which occasions that any local variation is evanescent compared to the whole quantity of salt.

If we take the mean numbers for the five regions of the Atlantic between the southernmost point of Greenland and that of South America, we find the mean quantity of salt for the whole Atlantic 35.833, while the sea between Africa and the East Indies has only 33.850; the sea between the East Indies and the Aleutic Islands, 33,569; and the South Sea, between the Aleutic Islands and the Society Islands, 35,219 per 1,000 salt. The Atlantic is thus that part of the ocean which contains the greatest proportion of salt, which result is rather surprising if we consider the vast quantity of fresh water which the rivers of Africa, America, and Europe pour in: of Africa four-fifths are drained into the Atlantic either directly or through the Mediterranean; it is most probably nine-tenths of America which is drained into the Atlantic, since the Cordilleras run close to the western shore of the continent; and of Europe, also, about nine-tenths of its surface sends its superfluous water to the Atlantic. This greater quantity of fresh water from the land, and the greater quantities of salts in the corresponding sea, seem to contradict each other, but can be explained by a higher temperature, and, as the result of this higher temperature, a greater evaporation.

Some of the large bays of the ocean have in the tropical or sub-tropical zone a greater mean than the Atlantic. Such are the Mediterranean, with 37.936 per 1,000 salt (mean of eleven observations); the Caribbean Sea, with 36,104 per 1,000 (one observation); the Red Sea, 43,067 per 1,000 (mean of two but little differing observations), which is the greatest salinity of the sea I know of.

In approaching the shores the sea-water becomes less rich in salts, a fact

which finds its explanation in the more or less great quantity of fresh water which runs into the sea. On such shores, where only small rivers flow out, the effect produced is but very trifling, as, for instance, on the western shores of South America. The effect of large rivers in diluting the sea-water is much greater than is generally supposed; thus, the effect of the La Plata River, whose mouth lies in about 30° of South latitude, was still observable in a sample of sea-water taken at 50° 31′ S. latitude, at a distance of 15° of latitude, or 900 English miles from the mouth of the river; at about the same distance the water of the North Atlantic Sea suffered a considerable depression in salinity, probably owing to the water of the St. Lawrence. This influence is of a double kind, partly in diluting the sea-water, partly in mixing it up with organic substances that will occasion its decomposition by putrefaction.

As the result of the *Challenger Expedition*, we quote the following, by J. Y. Buchanan, M.A. (the chemist of the expedition), from a paper read before the Royal Geographical Society in 1877:—

The source of saltness in sea-water is rock-substance, which has been disintegrated and decomposed by atmospheric influences.

The specific gravity* of the water from the surface was determined (at a temperature of 39° Fahrenheit) every day during the cruise when at sea, and from the bottom and intermediate depths as often as opportunity offered.

As far as the surface is concerned, the general results were as follows. The concentration of the waters of the Atlantic is greater than that of either the Pacific or the Southern Ocean, and it is greater in the North Atlantic than in the South Atlantic, although the actual maximum may be slightly higher in the South Atlantic. In the North Atlantic the maximum (1.0275) was observed in 22° N. latitude, and 40° W. longitude, from which point it diminishes in all directions. (On the South Coast of Iceland it was 1.0260.)

If we consider the water below the surface, as shown in the vertical sections, we find, in the Atlantic, that in the concentration-areas the specific gravity diminishes until a minimum (1.0260) is reached at a depth of about 800 or 1,000 fathoms, after which it increases slightly down to the bottom. In investigating the causes of the variations in specific gravity in the ocean, we find that they depend on the means available for removing or supplying *water*. Thus the areas of greatest concentration coincide with those where the dry trade-winds are constantly blowing, taking their rise in the lower Temperate latitudes, and proceeding in their course always from colder to warmer regions, so that, for the first part of their journey, at least, although they are continually taking up moisture, their capacity for doing so is continually increasing. Hence the great concentration of the water in the steady Trades of the Atlantic.

The observations make it probable that in the Atlantic the water from the

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* According to Erman's elaborate investigations, the weight of salt in 1,000 parts of water of different specific gravities is—

Specific gravity	1.025	1.026	1.027	1.028
Salts per 1,000	33.765	35.049	36.343	37.637

surface, down to a depth of 1,000 fathoms, has on the whole a flow *inwards*, or from South to North, and below that depth and down to the bottom it appears to have an opposite flow, thus providing for the removal of the salt which otherwise would accumulate in the North Atlantic. The Atlantic thus presents on a larger scale what is observed in the Mediterranean, where the mean drying power of the atmosphere is higher than even in the North Atlantic. In the Pacific, owing to its form and general climate, these conditions are not so evident.

The Gulf Stream was very clearly indicated simply by the specific gravity, or rather the edge of it, where the warm and dense water of the Gulf Stream met what was called the "cold wall" of the Labrador Current. The Equatorial Currents, also, were very marked, being fresh. The Agulhas Current of South Africa showed similar variations in density.

Circulation.—That there is interchange between all the water in the oceans is shown in (168), page 314. Of the means by which this interchange is produced, numerous theories have been advanced, and it is only in recent years that any really reliable *data* has existed to elucidate the subject. At the present time, Physicists are pretty well agreed that the great cause of the circulation of the water is its varying specific gravity. This specific gravity, or density (see above), is regulated chiefly by temperature, but also by the amount of salt contained in the water. Without going into further details, the simple theory which recent investigations have strengthened is that a cold under flow of water is continually kept up from the polar to the equatorial regions.* This theory Professor Lenz, of St. Petersburg, advanced as *an inevitable deduction* from the facts ascertained by the remarkable series of observations on the Temperature and Specific Gravity of Oceanic Water at various depths, which he had made in the second voyage of Kotzebue, during the years 1823-6. He drew from these results the very conclusions which now derive remarkable confirmation from the temperature soundings and specific gravity observations of the *Challenger*, viz.: 1. The doctrine of a deep under-flow of glacial water from each Pole to the Equator. 2. The ascent of polar water towards the surface under the Equator, as evidenced by the rise of the bathymetrical isotherms, by the keeping down of the surface temperature, and by the low (polar) salinity of equatorial surface water. 3. The movement of the upper stratum of oceanic water from the equatorial region towards each Pole, as the necessary complement of the deep polar under-flow. 4. The dependence of this double movement upon the disturbance of hydrostatic equilibrium constantly main-

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* That *under-currents* do actually exist is well-known. (See pp. 401-2.) H.M.S. *Challenger* several times tested the rate and direction of the under-current by means of a wooden framework, covered with canvas, lowered by a rope to the depth at which the current was to be tested; the upper end of the rope being attached to a buoy which floated on the surface; and, after allowing for the effect of the surface-current, showed by its progress the direction of the current at the depth where the framework was floating. This same process was used by Dr. Carpenter in testing the flow of cold water from the Atlantic into the Mediterranean through the Straits of Gibraltar. It is, of course, possible that these under-currents may in places be so near the surface as to affect the course of a ship deep in the water.

tained by polar cold and equatorial heat. The opposition which has been raised to this doctrine of a thermal circulation has mainly rested on one or both of two pre-conceptions:—1. The origination of all oceanic movements in the surface-action of wind. 2. The sufficiency of the Gulf Stream to produce that amelioration of the climate of north-western Europe.

We conclude this portion of our subject with some remarks by Sir Wyville Thomson:*—

"All the facts of temperature distribution in the Atlantic appear to favour the view that the entire mass of Atlantic water is supplied by an indraught from the Southern Sea, moving slowly northward, and interrupted at different heights by the continuous barriers which limit its different basins; but this involves the remarkable phenomenon of a vast body of water constantly flowing into a *cul de sac* from which there is no exit. When I suggested this view some years ago, I was asked, very naturally, how it was possible that more water could flow into the Atlantic than flowed out of it, and at that time I could see no answer to the question, although I felt sure that a solution must come some day. Now it seems simple enough; but in order to understand the conditions fully, I would ask my readers to recall the appearance of the Atlantic, and of the Pacific also, which is under exactly the same conditions. On the globe one sees much more clearly than on a map that the Atlantic is a mere tongue as it were of the great ocean of the water hemisphere stretching up into the land. The Arctic Ocean, with which it is in connection, is again a very limited sea, and nearly land-locked. The North Pacific is another gulf from this 'water-hemisphere,' but one vastly wider and of greater extent; while the South Pacific is included within the 'water hemisphere.'

"Although from the meridional extension of the continents to the southward, the water of the Atlantic is, as I have shown, directly continuous, layer for layer, with the water of the Antarctic basin, it must be looked upon not as being in connection with that basin only, but as being a portion of the great ocean of the water hemisphere; and over the central part of the water hemisphere precipitation is certainly greatly in excess of evaporation, while the reverse is the case in its extensions to the northward. The water is therefore carried off by evaporation from the northern portions of the Atlantic and of the Pacific, and this vapour is hurried down towards the great zone of low barometric pressure in the southern hemisphere; the heavy, cold water welling up from the southward into the deepest parts of the northward extending troughs to which it has free access, to replace it. It is unfortunate that we have, as yet, scarcely sufficient data to estimate the relative amount of rain and snow in the northern and southern hemispheres, but the broad fact that there is very much more in the southern is so patent as scarcely to require proof. This excess becomes still more apparent when we include, as we must do, in this source of supply of water to the North, the tropical region of the South Pacific, which forms part of the great ocean."

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* Voyage of the *Challenger*, vol. ii., pp. 324—326.

Animal Life in the deep sea is so intimately related to the temperature of the bottom, as obviously to be determined by that condition in a much greater degree than by its depth. This was very strongly impressed on Sir Wyville Thomson and myself in our early investigations. For in the deep trough lying N.E. and S.W. between Shetland and the Farœ Islands, which, as having been our cruising ground in 1868, I have ventured to call the "*Lightning* Channel," we found at corresponding depths of between 500 and 600 fathoms, and sometimes within a few miles of each other, two areas whose temperatures differed by more than 13° Fahr.; the bottom temperature of the "warm area" being about 43°, whilst that of the "cold area" was somewhat below 30°. The Faunæ of these two areas showed the most marked diversities. And I was thus led in my report for 1869 to express my entire concurrence in the speculation thrown out some years previously by Professor Lovén, that "there exists in the great Atlantic depression, perhaps in all the abysses of our globe, and continued from pole to pole, a fauna of the same general character, thriving under severe conditions, and approaching the surface where none but such exists, —in the coldest seas."* This expectation has been most remarkably confirmed by the *Challenger* researches; one of the most important of the general results of that expedition being the recognition of an abyssal Fauna essentially the same over the whole oceanic area that is reached by the glacial underflow, without any relation whatever to the terrestrial climate of the locality, and scarcely showing any difference according to its Arctic or Antarctic derivation. Thus we see that, even at the present time, the essential conditions of a "glacial epoch" prevail upon the Deep Sea bed from each Pole to the Equator; so that the presence of Arctic types of animal life in any *marine* deposit of temperate or even tropical zones, affords not the least evidence, *per se*, of the former extension of glacial action over the *land* of these localities.—*Dr. Carpenter.*

"The most prominent and remarkable biological result of the most recent investigations is the final establishment of the fact that the distribution of living beings has no depth limit; but that animals of all the marine invertebrate classes, and probably fishes also, exist over the whole of the floor of the ocean. My present impression is, that, although life is thus universally extended, the number of species and of individuals diminishes after a certain depth is reached, and that at the same time their size usually decreases.

"Using all precautions and with ample power and the most complete appliances,† it is extremely difficult to work either with the Dredge or with

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* "Proceedings of the Royal Society," Nov. 18, 1869, p. 475. The similarity of Antarctic to Arctic forms of Marine life had, indeed, been previously noticed by Sir James Ross; and had been attributed by him to the prevalence of a "similar temperature" over the whole intervening Sea bed. This temperature, however, he erroneously supposed to be 39·5° Fahr.

† In the examination of the Animal Life three forms of apparatus were used by H.M.S. *Challenger*. 1. A *dredge*, consisting of a dredge bag attached to an iron frame 4½ft. long by 1½ ft. broad. To the bottom of the frame was attached a bar, bearing *tangles* of rope yarn (the invention of Captain Calver) in order to entrap various animals while passing over the bottom. The dredge bag usually came up from the bottom at great depths, full of mud (*globigerinae ooze, &c.*), but on one occasion a huge block of syenite was brought up in the

the Trawl at depths approaching or exceeding 3,000 fathoms. A single dredging operation in such depths takes a long time; the dredge is put over at daybreak (the ship being kept as nearly as possible stationary), and it is usually dark before it is recovered, so that the number of such operations must be comparatively small. We must therefore bear in mind that only an infinitesimally small portion of the floor of the ocean at depths over 2,500 fathoms has yet been explored.

"As we had previously anticipated, the fauna at great depths was found to be remarkably uniform. Species nearly allied to those found in shallow water of many familiar genera were taken in the deepest hauls, so that it would seem that the enormous pressure, the utter darkness, and the differences in the chemical and physical conditions of the water, and in the proportions of its contained gases depending upon such extreme conditions, do not influence animal life to any great extent.

"The geographical extension of any animal species, whether on land or in the sea, appears to depend mainly upon the maintenance of a tolerably uniform temperature, and the presence of an adequate supply of suitable food.

"There is every reason to believe that the fauna of deep water is confined principally to two belts, one at and near the surface, and the other on and near the bottom; leaving an intermediate zone in which the larger animal forms, vertibrate and invertibrate, are nearly or entirely absent."—*Sir Wyville Thomson.* (Voyage of the *Challenger*, vol. ii.)

AN ACCOUNT OF THE FINE DUST WHICH OFTEN FALLS ON VESSELS IN THE ATLANTIC OCEAN.

By Charles Darwin, Esq., F.R.S., F.S.S.

Many scattered accounts have appeared concerning the dust which has fallen in considerable quantities on vessels on the African side of the Atlantic Ocean. It has appeared to me desirable to collect these accounts, more especially since Professor Ehrenberg's remarkable discovery that the dust consists in considerable part, of Infusoria and Phytolitharia. I have found fifteen distinct statements of dust having fallen; and several of these refer to a

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mouth of the dredge from a depth of 1,340 fathoms, about 150 miles southward of Cape Sable in the North Atlantic. 2. The *Deep-sea Trawl*, a conical bag 30 ft. in length, weighted at its bottom end, and suspended by one side of its mouth to a beam of wood; the other side of the mouth, which drags along the sea-bottom, hangs loose, and in order that the bag may keep open is weighted with some pieces of lead. The mouth of the Trawl-bag is fitted with a netted funnel arrangement which prevents the escape of animals after their capture. 3. An *ordinary trawl-net*, kept open at its mouth by an iron ring, was dragged behind the vessel at small depths. The accumulators (p. 816), to which the dredge ropes were attached were slung from the mainyard arm of the *Challenger*, and the hauling in of the dredges was effected by a donkey engine.

period of more than one day, and some to a considerably longer time. Other less distinct accounts have also appeared. At the end of this paper I will give the particular cases, and will here only refer to the more striking ones, and make a few general remarks.

The phenomenon has been most frequently observed in the neighbourhood of the Cape Verde Archipelago. The most southern point at which dust is recorded to have fallen is noticed by Captain Hayward,* on whose vessel it fell whilst sailing from lat. 10° N. to 2° 56′ N.; the distance from the nearest of the Cape Verde Islands being between 450 and 850 miles. Respecting the northern limit, the water for a great distance on both sides of Cape Noon (in lat. 38° 45′) is discoloured, owing in part, according to Lieutenant Arlett,† to the quantities of falling dust. Hence the phenomenon has been observed over a space of at least 1,600 miles of latitude. This dust has several times fallen on vessels when between 300 and 600 miles from the coast of Africa: it fell, in May, 1840, on the Princess Louise ‡ (in lat. 14° 21′ N., long. 35° 24′ W.) when 1,030 miles from Cape Verde, the nearest point of the continent, and therefore halfway between Cayenne in South America and the dry country North of the Senegal in Africa.

On the 16th of January, 1833, when the *Beagle* was 10 miles off the N.W. end of St. Jago, some very fine dust was found adhering to the under side of the horizontal wind-vane at the mast-head; it appeared to have been filtered by the gauze from the air, as the ship lay inclined to the wind. The wind had been for twenty-four hours previously E.N.E., and hence, from the position of the ship, the dust probably came from the coast of Africa. The atmosphere was so hazy, that the visible horizon was only 1 mile distant. During our stay of three weeks at St. Jago (to February 8th), the wind was N.E., as is always the case during this time of the year; the atmosphere was often hazy, and very fine dust was almost constantly falling, so that the astronomical instruments were roughened, and a little injured. The dust collected on the *Beagle* was excessively fine-grained, and of a reddish-brown colour; it does not effervesce with acids; it easily fuses under the blow-pipe into a black or grey bead.

In 1838, from the 7th to the 10th of March, whilst Lieut. James, in H.M.S. *Spey*, was sailing, at the distance of from 330 to 380 miles from the continent, between lat. 21° 10′ N., long. 22° 14′ W., and lat. 17° 43′ N., long. 25° 54′ W., considerable quantities of dust fell on his vessel, four packets of which, together with a written communication, I owe to the kindness of Mr. Lyell. The dust which fell on the first day (or the 7th) was preceded by a thick haze, and it is coarser than that which fell on the succeeding days. It contains numerous irregular, transparent, variously-coloured particles of stone about the 1-1000th of an inch square, with some few a little larger, and much fine matter. The fact of particles of this size having been brought at least 330 miles from the land is interesting, as bearing on the distribution of the sporules of cryptogamic plants and the ovules of infusoria. The dust

* Nautical Magazine, 1839, p. 364. † Geographical Journal, vol. vi. p. 296.
‡ Edinburgh New Philosophical Journal, vol. xxxii. p. 134.

which fell on the three succeeding days resembles in appearance and in its action under the blow-pipe, that collected by myself off St. Jago, and is so excessively fine, that Lieut. James was obliged to collect it with a sponge moistened with fresh water. As the wind continued nearly in the same direction during the four above-mentioned days, and the distance from the land was only a little increased after the first day, it would appear probable that the coarser dust was raised by a squall with which the breezes on this coast so often begin blowing.

With respect to the direction of the wind during the falls of dust, in every instance where recorded it has been between N.E. and S.E.; generally between N.E. and E. In the case, however, given by the Rev. W. Clarke,* a hazy wind which had blown for some time from E. and S.E., first fell calm, and was succeeded for a few hours by a S.W. wind, and then returned strongly to the East; during this whole time dust fell. With respect to the time of year, the falls have always occurred in the months of January, February, March, and April; but in the case of the Princess Louise in 1840, as late as the 9th of May. In the one year of 1839, it has chanced that dust has been recorded as having fallen in the Atlantic (as may be seen in the references) on the 14th and 15th of January, and on the 2nd, 4th, 9th, 10th, 11th, 12th, and 13th of February. I may add, that Baron Roussin,† during his survey of the north-western African coast, found that, whilst the wind keeps parallel to the shore, the haze and dust extend seaward only a short distance; but when during the above four specified months, the harmattan blows from the N.E. and E.N.E., accompanied by tornadoes, the dust is blown far out, and is raised on high, so that stars and all other objects within 30° of the horizon are hidden.

Another account is given by Mr. George Peacock, as having occurred on board H.M.S. *Winchester*, in February, 1829:—"Shortly after leaving Teneriffe, when in about lat. 25° 30′ N., and some 250 miles from the coast of the Great Desert of Sahara, the weather became very hazy and sultry, and one morning, at daylight, the lays of the lower rigging were observed to be filled with fine, reddish-brown dust, and the decks, whilst being washed, were in as muddy a state as the pavement of a street after a shower, This hazy unpleasant weather continued all day, and quite obscured the horizon; rendering it difficult to observe even the crest of the waves beyond a few cables' lengths, and the sun appeared as viewed through the red shade glass of a sextant. Towards evening it grew worse, the wind became light, and the haze was almost as dense as a London November fog, the air full of fine red dust, which made it difficult to breathe. So thick was it that a young man having fallen overboard, the boats which were lowered in search of him could neither find him nor scarcely find the ship for some time afterwards, and this though guns were fired."

From the several recorded accounts,‡ it appears that the quantity of dust

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* Proceedings of the Geographical Society, vol. iv. p. 145.

† Nautical Magazine, 1838, p. 824.

‡ Nautical Magazine, 1837, p. 291; Edinburgh Philosophical Journal, vol. vii. p. 402 Howard Malcolm's Travels, vol. ii. p. 200.

which falls on vessels in the open Atlantic is considerable, and that the atmosphere is often rendered quite hazy; but nearer to the African coast the quantity is still more considerable. Vessels have several times run on shore owing to the haziness of the air; and Horsburgh * recommends all vessels, for this reason, to avoid the passage between the Cape Verde Archipelago and the main land. Roussin, also, during his survey, was thus much impeded. Lieut. Arlett found the water so discoloured,† that the track left by his ship was visible for a long time; and he attributes this, in part, to the fine sand blown from the deserts, "with which everything on board soon becomes perfectly caked." ‡

Professor Ehrenberg has examined the dust collected by Lieut. James and myself; and he finds that it is in considerable part composed of Infusoria, including no less than sixty-seven different forms. These consist of thirty-two species of silicious-shielded *Polygastrica;* of thirty-four forms of *Phytolitharia*, or the silicious tissues of plants; and of one *Polythalamia*. The little packet of dust collected by myself would not have filled a quarter of a teaspoon, yet it contains seventeen forms. Professor Ehrenberg remarks that, as thirty-seven species are common to several of the packets, the dust collected by myself, and on four successive days by Lieut. James, must certainly have come from the same quarter; yet mine was brought by an E.N.E. wind, and Lieut. James' by a S.E. and E.S.E. wind. The Infusoria are all old known species, excepting one allied to a Hungarian fossil; and they are of fresh-water origin, with the exception of (*Grammatophora oceanica* and *Textilarea globulosa*), which are certainly marine. Professor Ehrenberg could not detect any of the soft parts of the Infusoria, as if they had been quickly dried up, and hence it would appear that they must have been caught up by the wind some time after having been dead. The greater number of the species are of wide or mundane distribution; four species are common to Senegambia and South America, and two are peculiar to the latter country; moreover, it is a very singular fact, that out of the many forms known to Professor Ehrenberg as characteristic of Africa, and more especially of the Sahara and Senegambia regions, none were found in the dust. From these facts one might at first doubt whether the dust came from Africa; but considering that it has invariably fallen with the wind between N.E. and S.E., that is, directly from the coast of Africa; that the first commencement of the haze has been seen to come on with these winds; that coarser particles have first fallen; that the dust and hazy atmosphere are more common near the African coast than farther in the Atlantic; and, lastly, that the months during which it falls coincide with those when the harmattan blows from the continent, and when it is known that clouds of dust and sand are raised by it, I think that there can be no doubt that the dust which falls in the Atlantic does come from Africa. How to explain the enigma of the absence of characteristic African forms and of the presence of two species from South America, I will not pretend to conjecture. Finally, I may remark that the circumstance of such quantities of dust being

* Horsburgh's East India Directory, p. 11.

† In Tuckey's Narrative of the Congo Expedition, p. 10.

‡ Nautical Magazine, 1847, p. 354.

periodically blown, year after year, over so immense an area in the Atlantic Ocean, is interesting, as showing by how apparently inefficient a cause a widely-extended deposit may be in process of formation; and this deposit, it appears from the researches of Professor Ehrenberg, will in chief part consist of fresh-water Polygastrica and Phytolitharia.

This concludes Professor Darwin's remarks.

The following further information on this subject is derived from 59 observations of red dust recorded in the log-books examined at the Meteorological Office, in the study of the region between 10° S. and 20° N. from 10° to 40° W. Of these 59 observations only one occurs in square 38; 24 in square 39, and 14 in square 40; 13 in the northern half of square 3, and 7 in the northern half of square 4 (see diagram, page 466). In the different months the numbers are as follows:—January 12, February 5, March 6, April 12, May 1, June 5, July 3, August 0, September 0, October 3, November 0, December 12.

The *most westerly* observations are—lat. 17° 30′ N., long. 38° 30′ W., 10.0 a.m., 13th April, 1859. Red dust still falling; wind N.E. by E., force 4. Ship from the southward. In lat. 14° 30′ N., long. 37° 30′ W., 10 a.m., 12th April, 1859. Red dust still falling in large quantities; wind N.E. by E. force 4. Ship from the southward. In lat. 12° 30′ N., long. 38 °30′ W., 4 p.m., 29th December, 1865. Sails tinted with "cloud" dust; wind E. by N., force 6. Ship from the southward. At 6 a.m. the clouds were said to be tinted brick dust colour. At noon, indications of "cloud" dust. The most *southerly* observation is in lat. 4° 30′ N., long. 24° 30′ W., January 15th, 1866. Our sails quite coloured red with African dust; wind N.E. Ship from southward

Land-birds and *insects* have been frequently seen far out at sea; and in the region we are now treating of, the ships' logs record many instances, by far the most numerous naturally occurring between longitudes 20° W. and 30° W., or in the tracks of vessels to the Equator. The latitude however points to West Africa as the origin of these remarkable wanderers; between 3° N. and 10° N. (long. 20° to 30° W.) about 75 observations are recorded, while between 3° N. and 10° S. only 9 reports. It would clear up many doubts, if the *species* of the various strays was known; doubtless many of the insects were shipped in the caterpillar or chrysalis state, and emerged as perfect insects during the voyage. Some of the land-birds too, no doubt, had escaped from passing vessels.

IV.—ON MAGNETISM AND THE COMPASS.

Concerning the history of the magnetic needle, we have many and vague notices of its high antiquity. It is mentioned by Homer and Aristotle and by many subsequent classical writers; the first account we have of this is, that it was known, in Europe, at the time of the crusades, in about A.D. 1150, and it is very probable that the knowledge was derived from the Arabians, during those expeditions. But the Chinese were acquainted with it many years before this. We are told by the Jesuit missionary, Du Halde, that the Chinese Emperor, Hoang ti, possessed an instrument which pointed to the South, so early as the year 2634 B.C., or 4,500 years ago; the same

author gives subsequent notices of the compass in China, proving its very great antiquity among that people.

It has usually been considered that Columbus, in his voyage from Portugal, on the discovery of America, first observed the Variation of the needle from the true North. But it is not improbable that the Variation was discovered nearly 200 years before Columbus made this change known, as it is mentioned in one of the earliest treatises on magnetism by Peter Adsiger, in 1269; the authenticity of this, however, is doubted by some. The wonderful property of the Dip of the needle was first observed by our countryman, Robert Norman, a maker of compasses, in 1576.

Magnetism is a principle which is evidently allied to, if it is not identical with, electricity and galvanism. For, in the causing any or either of these principles to become evident to our senses, we produce, at the same time, the others; and it may be here stated, that five apparently dissimilar effects are inevitably caused in the production of either; these are—light, heat, chemical action, electricity, and magnetism. By the production of *light* we cause heat and chemical affinity, and these will also produce *electricity*, and will cause the magnetic needle to swerve from the meridian. By the electric fluid we produce *light*, *heat*, and the other phenomena; and the magnetic needle is a measurer, by its deflections, of the most minute portions of galvanism. From the *magnet* a spark can be produced, absolutely similar in appearance and effect, to that of electricity and galvanism; and there is a positive and negative, or North and South, pole to the magnet, and these attract or repel each other.

There is one phenomenon connected with these sciences of very great importance in practice, and that is, that of *induction;* a substance electrified *positively* will *induce* a state of *negative* electricity, or will cause a body to be negatively electrified, that is within its influence; the North pole of a magnet will iduce an opposite pole in that of another piece of iron, in certain positions with respect to the magnetic meridian and itself. Thus, the iron employed in the construction of a ship, or contained in its cargo, may all become, by *induction*, temporary magnets, and have a most marked and important effect upon the compass by which it is steered; and it is this cause which is too frequently overlooked—that of the Local Deviation—which has caused enormous errors in reckoning, and consequently the loss of many vessels. As scientific detail is out of our province, we must refer the reader to those works more expressly treating on the subject.

Terrestrial Magnetism.—The magnetism of the earth, by which the direction, the dip, and the intensity of the force of the magnetic needle is controlled, is still involved in some obscurity, and no perfectly satisfactory system or theory has hitherto been framed to account for the multifarious changes and phenomena of the compass needle. Among the more modern enquirers into the source of this most wonderful principle are Professor Hansteen, Mr. Bain, Mr. Barlow, Mr. Christie, Sir Edward Sabine, Captain Johnston, Mr. Archibald Smith, Capt. Evans, R.N., and many others. From their labours we have arrived at a tolerably correct notion of the *general effects* of magnetic phenomena; and from these the laws by which they are governed have, in some measure, been deduced.

Now the most reasonable supposition is, that the earth itself is a magnet.

or that magnetic currents exist on its surface in certain directions, causing the various deflexions of the needle; whether this magnetism is *induced* from the sun, or other source, or whether the earth is in a positive and permanently magnetic state, does not affect the present question. From certain changes in the compass, perhaps it might be inferred, that the magnetism is *induced* by temperature (heat) from the sun; or that the ferruginous portions which enter so largely into the composition of the earth, have received an inductive magnetism from the same source.

In 1863 Dr. Edmund Halley published a theory of magnetism, in which occur the following ideas:—that the earth's magnetism was caused by *four piles or points of attraction*, two of them near each pole of the equator; and that in those parts of the world which lie nearly adjacent to any one of those magnetic poles, the needle is governed thereby, the nearest pole being always predominant over that more remote. This view of the earths's magnetism has been supported by the results of the labours of Professor Hansteen, one of the chief promoters of the science. From his most valuable work (*Magnetismus der Erde*, Christiania, 1817), his views may be learned. Having collected all the observations of value that had been made on the Variation of the needle, he proved that there were *faur points* of convergence among the lines of Variation; viz., a weaker and a stronger point, in the vicinity of each pole of the globe. This, combined with the result of Sir D. Brewster's inquiries, will certainly lead to the view of the connexion between the heat of the earth and its magnetism. Professor Hansteen considers that the strongest poles, N.S., lie almost diametrically opposite to each other, and the same is true of the weaker poles *n.s.* These four poles he found to have a *regular motion* obliquely; the two northern ones N.*n.*, from West to East, and the two southern ones S.*s.*, from East to West. The following he found to be their periods of revolution, and their positions in 1830:—

	Long. from Greenwich.	Time of revolution round each pole of the earth.
Pole N. 69° 30′ N.	87° 19′ W.	1,740 years.
Pole S. 68° 40′ S.	131° 47′ E.	4,609 —
Pole *n.* 85° 6′ N.	141° 17′ E.	860 —
Pole *s.* 78° 29′ S.	137° 45′ W.	1,304 —

From calculations based upon subsequent observations he slightly varied these positions and periods; but he has shown very clearly that the changes in the Variation and Dip of the needle, in both hemispheres, may be well explained by their motion.

These four magnetic poles or points on the earth's surface, over which the dipping-needle would stand vertical, are separated by a magnetic equator, which is not coincident with the earth's Equator, but is an irregular circle, which crosses it in three points, according to M. Duperrey, or in four points, according to M. Biot and Professor Hansteen; on this circle, of course, the dipping-needle stands horizontal.

Respecting the North Atlantic Ocean, we may here state that the magnetic crosses the terrestrial Equator in about long. 20° E. (in the Bight of Biafra), and proceeds westerly across the Atlantic to the coast of Brasil, which it

touches in lat. 16° S. The line of equal Dip, at 70°, runs from the Bristol Channel, curving S.W. and W., to about Charleston, U.S.; between these lines the lines of equal Dip (or *Isoclinal lines*) form regular divisions.

The mariners' compass, as generally used, exhibits the direction of the magnetic meridian only; but in treating of the magnetic needle, three points are to be inquired into—these are, the Variation, or *declination;* the Dip, or *inclination;* and the *intensity* of the magnetic force; and to the elucidation of these the philosphers in all quarters of the globe are at present engaged.

The Declination, or Variation.— With this branch of the subject every sailor is perfectly familiar, and any comment on its actual state is therefore unnecessary. But this Variation is not constant. There are several elements of change in this part of the magnetic force, for it undergoes secular, annual, mensual, diurnal, and also irregular changes. The *secular* change is a progressive alteration observed in the direction of the magnetic needle during a series of years. Thus, in 1576, Robert Norman found the compass at London to point 11° 15′ *East* of North; in 1658, it pointed true North; it was on the increase in 1819, when it was 24° 41′ *West* of North; and since then it has been retrograding, and in December, 1870, was 19° 20′ 56″.

The *mensual* change is according to the season of the year. It was first noticed by Mr. Canton about the year 1756. It amounted, in January, to 7′ 8″; in March, 11′ 17″; in June, 13′ 21″; in September, 11′ 43″; and in December, 6′ 58″. These are the diurnal changes, which vary in amount in different parts of the year.

The *diurnal* change is thus given from the recent observations of Professor Lloyd:—"The mean daily curve of the changes of Declination for the entire year exhibits a small easterly movement of the North end of the magnet during the morning hours, which reaches its maximum about 7 a.m. After that hour the North end moves rapidly westward, and it reaches its extreme westerly position at 1.10 p.m. It then returns to the eastward, but less rapidly, the easterly deviation becoming a maximum about 10 p.m.; the mean daily range equals 9.3′."

The *irregular* changes or magnetic storms, as they have been termed, occur without any previous notice, and are of very great extent; some of them almost throughout the globe. At times this deviation amounts to 2°.

The ascertained Variation of the compass in various parts of the Atlantic are attached to Tables of Positions in the former part of this work, and are also given on the Chart facing page 442.

The Dip, or Inclination.—The Dip of the needle, as we have already had occasion to observe, is the angle which a well-balanced needle forms with the horizon after it is rendered magnetic, and when it has the power of free motion in the plane of the magnetic meridian. As before stated, this angle varies in different parts of the globe, being at zero on the magnetic Equator, and 90° on the magnetic poles. The Dip, like the Variation, undergoes a continual change, increasing in some parts of the world and diminishing in others. Thus at Paris, in 1761, it was 75°; in 1829, only 67° 41′. At London, in 1576, it was 71° 50′; in 1837, it was 69° 20′; in 1861, it was 68° 25′. The Dip is a very important element in magnetic consideration, and is too much overlooked by the sailor. The instruments for its measurement, however, are expensive and delicate, and require great nicety in

their management; for these reasons it is comparatively neglected; but as it is in some degree a measurement of the intensity of the magnetic force and also greatly modifies the directive power of the compass, it is very important to the mariner. When the needle is perpendicular, as it is over the magnetic pole, of course its directive force vanishes, although at that time the intensity of the magnetism is greatest. The diurnal change in the Dip amounts to 3′ or 4′, and is also about 15′ greater in summer than in winter.

The following table is extracted from one by Major (now Gen. Sir Edward) Sabine, in the "Phil. Trans." 1840, p. 135:—

Place.	Dip.	Observer.	Year.	Place.	Dip.	Observer.	Year.
	° ′				° ′		
Montreal	76 19*	Estcourt	1839	Curaçoa	38 39	Zarhtman ..	1833
Halifax	74 45	Estcourt	1838	Caraccas	37 16	Home	1836
Worcester	74 21	Loomis	1839	St. J. de Nicaragua....	34 43	Barnett.....	1839
Cambridge....	74 20	Loomis	1839	Demerara....	33 57	Home	1837
Springfield....	74 11	Bache	1834	Chagres	32 30	Home	1834
Providence....	74 0	Loomis	1839	Pará	24 8	Home	1835
Hartford.....	73 58	Loomis	1839	Madeira	59 42	Sabine	1847
New Haven ..	73 27	Loomis	1839	Bahia, Brasil	5 1	Sulivan.....	1839
New York	72 52	Loomis	1839	Rio Janeiro ..	10 0†	Sulivan.....	1839
Washington ..	71 21	Loomis	1839	London.....	68 25*	Mag. Survey .	1859
Bermuda	67 31	Home	1837	Terceira	68 6	FitzRoy	1836
Nassau	56 13	Barnett	1839	River Tagus..	60 39	Lamont	1858
Contoy Island .	49 48	Barnett	1838	Paris	67 34	Arago	1835
St. Thomas....	49 29	Zarhtman ..	1834	Tenerife	57 47	Wickham	1837
Antigua	48 46	Home	1835	Port Praya ..	45 46	FitzRoy	1836
Alta Vela	47 39	Home	1835	Egga, on the Niger.....	13 51	Allen.....	1833
Jamaica	47 19	Barnett	1834	Fernando Po .	0 48	Allen.....	1833
Bardados	43 37	Home	1835	Ilhas das Rolas	7 44†	Allen.....	1833
Cape Gracias á Dios.....	41 4	Barnett	1835				

The Intensity.—The intensity of the magnetism of the earth varies also with time and place. It is the power of the earth to bring an oscillating needle to a state of rest; and it is in proportion to the squares of the number of vibrations per second. The lines of equal intensity would at first seem to coincide with those of equal dip, but, in consequence of the double magnetic polar axes, they differ in their relation, though they still form regular and symmetrical curves. As the magnetic latitude increases so does the intensity, but not the directive force; for, when a needle is on the magnetic equator, it naturally preserves its horizontality, and, consequently, the whole of its magnetism is employed in directing the needle towards the poles. But, in high magnetic latitudes, where the Dip is great, the means employed to keep it parallel with the horizon of course reduce very considerably its power of keeping in a North and South direction; and in the circum-polar regions the ordinary compass becomes so sluggish as to be of but little value to steer by.

Having thus very briefly sketched the general phenomena of terrestial magnetism, the reader will understand the general principles laid down by

* North end. † South end.

Dr. Halley and Professor Hansteen, that in the northern hemisphere the two points of convergence of the magnetic Variation or Declination by revolving around the pole of the earth will cause a local change in the Variation of all places lying in North magnetic latitude, and which, in the case of London, has amounted to 35½° in 455 years. The Dip, on the other hand, has changed but little, or 2½° in 260 years; this is obvious, because the two magnetic axes, while they change their terrestrial longitude in a considerable degree, do not vary much in latitude, and, consequently, will not greatly affect the Dip in places at some distance from them.

The points then interesting to the navigator are, first, the influence of the earth's magnetism upon his compasses, and the influence the ship and her iron has upon it in neutralising or modifying the first; the second, namely, the local Deviation, is a subject which has become magnified into vast and vital importance since the introduction of so much iron into the fabric of wooden ships, and the daily increasing number of iron ships.

The North Atlantic Ocean has this peculiarity, in a magnetic sense, that it has over nearly all its area but one kind of magnetism—westerly Declination (or Variation) and northerly Inclination (or Dip). The magnetic Equator passes, as before said, obliquely across the terrestrial Equator from Africa to Brasil, the line of No Dip being to the South of this. The line of No Variation will be seen by the chart.

Now, as will be seen presently, as the force of the ship's magnetism diminishes, so does that of the earth increase in its influence on the compass, so that a ship's *corrected* compass does not hold the same relative position with respect to both with the same correction into a different magnetic latitude. Thus, a vessel with a large original error in England will find that error reduced perhaps to one-half on reaching the Equator; and if sailing northwards a very different relation will be found.

This is especially to be noticed on sailing into the Gulf of St. Lawrence, or anywhere in a N.W. direction towards America. Frequently a ship may be standing on one course to the southward of West across the Atlantic, and then suddenly bears up to N.W.; and then passing rapidly towards the magnetic pole, the relation between the earth's magnetism and that of the ship upon her compass undergoes a rapid and important change, which, unattended to, has doubtless been the cause of many embarrassments and accidents.

The Local Deviation of the Compass is its variation from the magnetic meridian, which may be caused, as already noticed, from a peculiar state of the atmosphere, Aurora Borealis, lightning, or the local attraction of the ship, iron, &c. This is a subject of inquiry, which was first explained by Capt. Flinders in the description of his surveys of the Australian coast. To this subject his attention was directed, not only by some anomalous differences which he found in the compasses that he used, but by others recorded by Mr. Wales, who had accompanied Captain Cook in the capacity of astronomer, and his deductions referring as they do to wooden vessels, are still held to be correct.

But the problem of local deviation in *iron ships* is a widely different one, and includes a large range of phenomena and considerations which have

hitherto been but little understood, and even now may not be established on a firm basis in all its particulars.

This important discussion upon the magnetism of iron ships began by Professor Airy's experiments recorded in the "Philosophical Transactions" for 1839. His conclusions were somewhat opposed by Dr. Scoresby in 1854, which was replied to in the "Mercantile Marine Magazine," in 1854 and 1855. To further investigate the still obscured principles involved in this very important topic, Dr. Scoresby undertook his well-known voyage to Australia and back in the *Royal Charter*, between February and August in 1856.

The attention of the shipping interest to this question was strongly called at the meeting of the British Association at Liverpool, in 1854, and the result was the formation of the Liverpool Compass Committee, who reported to the Government in 1855 and 1856, and the valuable series of observations they had collected were discussed by their able secretary, Mr. Rundell, and by Mr. Archibald Smith, Mr. Towson, and others, in 1857. One important conclusion since arrived at is stated by Mr. Archibald Smith as follows:—

"Whenever differences of opinion may be entertained as to applying corrections to the steering compasses of iron ships, it can hardly admit of question that every iron ship should have at least one compass removed as much as possible from the influence of iron and *not corrected* by magnets, and should be swung at the beginning and end of every voyage of any length, and the Deviation of the uncorrected and corrected compasses (if any) observed. No man is competent to command an iron ship who is not competent to make these observations."*

The more refined calculations which can be entered into for determining the relation between a ship and her compass are given in a pamphlet by Archibald Smith, Esq., "Instructions for the Computation of a Table of the Deviations of a Ship's Compass," 1848, as a supplement to the "Practical Rules for ascertaining the Deviations, &c.," 1854.

Dr. Scoresby gives the following summary of leading deductions on the Character and Distribution and liability to change of the Magnetism of Iron Ships:—

(1.) *As to the sources of the intense magnetism of iron ships.*—Ships built of iron must not only be strongly magnetic, because of the vast body of this metal which is subjected to the action of terrestrial induction, but by reason of the elaborate system of hammering, as well as from the bending of the plates and bars during the progress of construction, there must be an *extremely high* development of the quality of *retentive magnetism*.

(2.) *Effect of the position of a ship when building.*—Each iron ship must have a special individuality of the magnetic distribution, depending *essentially on* position of the keel and head whilst building, such distribution having, in each individual case, a polar axis and equatorial plane conformable to those of the earth at the place where the ship is built.

(3.) *Magnetic lines of the inductive and retentive magnetism the same.*—Whilst

* Introduction to Dr. Scoresby's "Journal of a Voyage to Australia," by Archibald Smith, Esq., M.A., p. 48.

the spontaneous influence of simple induction must be to develop a transient magnetic condition, having in each individual case a polar axis and equatorial plane conformable to those of the earth at the place where the ship is built; so also the retentive magnetism developed during the building must have corresponding polar direction and distribution.

(4.) *Liability of original magnetic distribution to change.*—The original distribution of the magnetism, or casting of the magnetic lines, must be liable to change after the launching under any violent mechanical action on the ship, when lying with her head in a new direction, or sailing in remote regions of the globe, having very different directions of the earth's magnetic force.

(5.) *Sympathy of the compass with a ship's magnetic changes.*—All changes in a ship's magnetic condition must tend to produce disturbance in the action of compasses on or about the deck. And the effect must be, in however minute or insensible quantity in some particular cases, to change the amount of the original *deviations*.*

The proposition No. 4, above recited, was forfeited by the example of the loss of the *Tayleur*, a new iron ship about 2,000 tons, whose steering compass had originally a maximum deviation of 60°, which was corrected by a magnet. She met with severe weather, after leaving Liverpool, going down Channel; and if, as Dr. Scoresby supposed, the effect was to "shake out" the magnetism of building, and give a new magetism, this would leave the corrected magnets to produce a deviation which threw her on the Irish Coast.

It was this argument on the "retentive" condition of the magnetism of the ship induced by her building, that led to the controversy between Dr. Scoresby and Professor Airy, and caused the former undertaking, at his advanced years, the voyage to Australia, from the effects of which he may be said to have fallen a martyr to science.

Dr. Scoresby, in his letter to the Underwriters' Association of Liverpool, in 1854, draws up the following propositions, in addition to those he laid down in his later work of the "Voyage of the Royal Charter."—

Examples.

3. That the original magnetism and compass deviation are specially liable to change in *new* ships, when meeting with heavy weather on their first going to sea.

4. That a *change of course*, after long steering in one direction, is liable to produce a change in the compass.

5. That adjusted compasses are specially liable to change in the direction of over-compensation, and may dangerously mislead the navigator.

6. That a *stroke* of the sea may produce a sudden change in the compass.

7. That a stroke of lightning may change a ship's magnetism and compass deviation.

8. That a *hot* sun, shining *partially* on an iron ship, might change her magnetism.

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* "Journal of a Voyage for Magnetical Research," 1859, pp. 71, 72.

9. That permanent magnets applied for the adjustment of compass deviations must, with rare exceptions, tend to aggravate the error in ships going far into another hemisphere.

10. That a compass aloft affords an easy, practical, and, if duly elevated and prepared for, an effectual remedy for the ship's disturbing influence.*

The experience gained by the voyage of the *Royal Charter* showed that the blows and strains that she had experienced in her voyage out to Australia diminished, or, so to speak, shook out the inequalities in her compasses, which were observed before her sailing, to such an extent that the standard compass, which had originally a deviation of 20° to the port side when the ship's head was North, had this deviation reduced to 3° 22′ on her return to Liverpool; while the steering compass, which originally had been rather over-corrected, having an error of 1° 43′ returned with it 22° 25′; while the companion compass, having an error of 1° 43′ returned with it 17° 35′. This change was one which had evidently taken place in the retentive magnetism of the ship. The change shows the complete failure in such a voyage by *fixed magnets.*

In 1843, when the Compass Department of the Admiralty was established, the science and the instruments were in an equally bad condition. The labours of Capt. E. J. Johnson, R.N., F.R.S., however, soon put a new face on the matter, and much was done in his time towards developing the application of the principles enunciated. But the vast increase of iron shipping has caused greater requirements, as has been stated, and the sailor is very largely indebted to Capt. Fred. J. Evans, R.N., the present Hydrographer, who has produced an excellent series of Variation Charts (from which our diagram on page 442 has been taken); and also has devoted much talent to the investigation of the problem of the magnetism in iron ships. From his Report to the Hydrographer on the Deviation in the Iron Ships of the Royal Navy, April 18, 1860, we extract the following:—

On the nature of the magnetism in iron-built ships.—The magnetic influence of steam machinery having been reviewed, the nature of the magnetism of iron-built ships can be entered on free, to a certain extent, of conditions arising from this extraneous source of compass error, and those examples fairly elimininated where it tends to embarrass the discussion.

The investigation of the disturbance arising from the horizontal induction of the soft iron in the ship, or the co-efficient D, offers several novel and suggestive points of inquiry; the chief characteristics are—

1. That it has invariably a *positive* sign, causing an easterly deviation in the N.E. and S.W. quadrants, and a westerly deviation in the S.E. and N.W. quadrants.

2. That its amount does not appear to depend on the size or mass of the vessel, or direction when building, or on the iron beams.

3. That a gradual decrease in amount has occurred, when examined over a number of years, in nearly every vessel that has been reviewed.

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* "The Compass in Iron Ships," &c., by the Rev. W. Scoresby, D.D., pp. 67, 68.

4. That the value remains unchanged in sign and amount, on changes of geographic position, confirming theoretical deductions.

5. That a value for this coefficient, not exceeding 4°, and ranging between that amount and 2°, may be assumed to represent the average or normal amount in vessels of all sizes.

The opinion has been long entertained, that the original magnetism of an iron-built ship, or that acquired in the process of building, undergoes a rapid change after launching, and that from this cause accidents have occurred to recently launched and hastily equipped vessels. The records of ships of the Royal Navy do not illustrate this subject.

I have alluded to the importance of the conclusions to be derived from a review of the examples and cases given in this report; for although varying compass disturbances exist, and the inference is irresistible that they arise from the nature of the iron employed in the construction of the hull of the ship, there is no doubt that, by attention to a few leading principles in the building and equipment of iron ships, that larger and uncertain sources of error may be modified and reduced within limits both of fluctuation and amount, that will not seriously compromise the safety of the ship in the hands of an ordinarily prudent seaman.

The points of practical import to which I would invite attention are—

1st. The best direction, with reference to the magnetic meridian, for the keel and head of an iron ship to be placed for building, to ensure the least compass disturbance.

2nd. The best position and arrangement for a compass, to ensure small deviations, and permancy on changes of geographic position.

3rd. The changes to which the compass is liable from various causes when the foregoing conditions are fulfilled.

On the best Direction for Building an Iron Ship.

In those built head N.E., East, West, and N.W., strong *South* polarity (or an *attractive* force on the North end of the compass needle) obtains on one side of the ship adjoining the compass as usually placed between the middle section and the stern; the resulting disturbance is not lessened as the compass is moved in a fore-and-aft line within these limits.

In vessels built head S.E. and S.W., *North* polarity obtains under the same conditions.

In vessels built head North or South, the conditions arise, that in the former the attraction is toward the stern (the topsides in their action being neutral to a compass in the middle line of the deck), and diminishes in force as the compass is moved towards the bow. In the latter the law is reversed and small compass deviations are obtained as the stern is approached.

In an iron *sailing* ship, built head to South, there will be an attraction of the North point of the compass to the head; and if built head to North, a like attraction to the ship's stern; and so far there would seem to be no advantage in one direction over the other. But in the first case the topsides near the compass have weak magnetism; in the second case they are strongly magnetic; the first position seems, therefore, preferable.

In an iron steamship, built head to the South, the attraction due to machinery is added to that of the hull; whereas in one built head to the North, the attractive forces of hull and machinery are, in the northern hemisphere, antagonistic, and a position of small or no "semi-circular" deviation for the compass may generally be obtained. In iron steam-vessels engaged on the home or foreign trades in the northern hemisphere, this direction of build is therefore to be preferred.

On the Position and Arrangement of the Compass.

The position of the compass, whether standard or steering, must depend, as will have been observed from the foregoing conclusions, on the direction of the ship's build; that is, in those built head North, the compass must be as far removed from the stern as circumstances will permit; in those built South, placed as near to the stern as convenient, without approaching so close to the rudder-head or iron taffrail as to cause the ship's general magnetism to be overpowered by the magnetic influence of those masses.

In ships built East or West, there is little choice of position, except to avoid, as a general rule, proximity to vertical masses of iron: in vessels built with their heads on the intercardinal point, a position approximating to the bow or stern respectively, where the action from the topsides (to be determined experimentally) is at a minimum, is to be preferred.

Ample elevation above the deck, and to be strictly confined to the middle line of the ship, are the primary conditions of position for every compass in an iron ship, and no compass, whether steering or standard, should be nearer the iron deck beams than 4 ft.; for the steering compass this arrangement could be met by the use of a vertical card for the helmsman.

The standard compass, which as a rule I should recommend to be unvariably uncompensated, requires an elevation of at least 5 or 6 ft. from the deck, and to be fitted on a separated and permanent pillar or stand; it is by this superior elevation that the strong magnetic power of the iron beams and adjoining topsides are correspondingly lessened.

As every piece of iron not composing a part of, and hammered in the fabrication of the hull—such as the rudder, funnel, boilers, and machinery, tanks, cooking galleys, fastenings of deck houses, &c.—are all of a magnetic character differing from the hull of a ship, their proximity should be avoided, and, so far as possible, the compass should be placed so that they may act as correctors of the general magnetism of the hull.

A compass placed out of the middle line of the deck is affected by the nearest topside, and its deviations must necessarily be much increased if that topside has the dominant polarity, as in the ships built East or West.

Experience has proved that the practical value of mast or elevated compasses has in some cases been overrated; they are, in fact, affected by the ship's magnetism to an amount depending on their elevation and the direction of the ship's build; thus in ships built North and South, but especially the latter—the compass being on the mizen-mast—the deviations will be large comparatively. In ships built East or West, the deviations will be comparatively small, from the topside, which would affect a deck compass,

being more directly under the mast compass; they may therefore be useful in the latter cases, and valueless in a ship built head to the South. The wear and tear on the pivots and agate caps of mast-compasses, from the increased motion due to their elevation, require constant attention when they are employed.

3. *On various Sources of Error affecting a Compass placed under favourable Conditions.*

Errors arising from changes of geographic position, as also incidental causes of error due to anomalous rather than general conditions, have been brought under review in the general progress of this report. There is, however, one source of compass-error (that arising from the heeling of the ship) which has not been alluded to, as the ship in all the points hereto reviewed is assumed to be on an even keel.

The few experiments made in ships of the Royal Navy will be found in Table I., and they tend to prove, as also does the test of experience, that when the original compass deviations are small, the errors from heeling are generally small in proportion; and conversely, the exaggerated errors from heeling are the consequence of exaggerated errors while on an even keel. Ample elevation from the deck, in order to raise the compass above the level of the topsides and adjacent deck-beams, is one of the chief conditions for reducing this source of error.

With head built North, on heeling, the North end of compass needle will

			be *attracted* to the weather or nearest side from its *South* polarity.
,,	N.E.	,,	,, the same.
,,	East	,,	,, the same.
,,	S.E.	,,	the North end of needle will have but little error from the balanced conditions of North and South polarity of topsides.
,,	South	,,	the North end of needle will be *repelled* to the lee side by the *North* polarity of nearest or weather topside.
,,	S.W.	,,	the North end of needle will have but little error, as at S.E.
,,	West	,,	the North end of needle will be *attracted* to the weather or nearest side.
,,	N.W.	,,	,, the same.

These laws only hold good as long as the topsides in the immediate vicinity of the compass retain their dominant polarity due to their original direction of build in great Britain. If in South magnetic latitudes a change of polarity takes place, the conditions of heeling correspond to such change.

The maximum disturbance on heeling in all these vessels is when their heads are (by disturbed compass) magnetic North or South, and this disturbance vanishes when the head is East or West. This law of disturbance may be thus explained: when the vessel's head is North or South on an even keel (by disturbed compass), the needle lies parallel to the topsides by

their combined action, which neutralize each other; on heeling, the nearest topside exercises its then dominant polarity at right angles to the direction of the needle, and hence the maximum error. With the ship's head East or West, whether on an even keel or heeling, either pole of the compass needle points directly to the topsides, and is consequently unaffected except in a vertical plane.

As the amount of disturbance on heeling varies under the various conditions of direction of build, height of compass, and breadth of ship or distance of topsides, added to the prevailing permanent or inductive magnetic condition of the latter and the deck-beams, each ship must have an individual character, to be determined only by experiment or observation at sea. There are, however, strong grounds for inferring that by a judicious position of the compass, so as to ensure small errors while on an even keel, the errors arising from a ship's heel will be so proportionally reduced as not practically to affect the navigation of the ship in the hands of a prudent seaman.*

CLASSIFICATION OF THE CLOUDS.

Since the discovery of Buys Ballot's Law (p. 184), and of the cyclonic and anti-cyclonic gales of extra-tropical latitudes the study of the clouds has assumed a new importance. To the remarks of the Hon. Ralph Abercromby (266), we may add the following notes made at a lecture delivered in November, 1878, by the Rev. W. Clement Ley, M.A., F.M.S., who has for many years devoted his spare time to the study of this subject. In the first place it requires a practiced eye for cloud observations, and this no person has a better chance of acquiring than the seaman. There is at present not enough known of the subject to lay down any very reliable rules, but in the case of storms which pass over the British Isles it is observed that the advancing half of the storm first shows a band of *cirrus stratus* around its semi-diameter; this is followed by a bank of *nimbus* or rain cloud; *cumulus*, accompanied by showers, follows with the succeeding half of the storm, and behind this, *cirrus* and *stratus*. Outside the area of high wind, on the left side of the advancing storm, the weather is dry and hazy. Another remarkable feature is the direction taken by the higher clouds, for instance, with the wind in one of these storms blowing on the observer's back, the clouds high in the atmosphere indicate that the direction of the wind is from left to right of the observer, which would seem to show a rising of the wind in a spiral form.

"The researches of Mohn, Hildebrandsson, Buchan, Clement, Ley, and others, seem to prove that in all cases which they have investigated by means of wind direction and the motion of *cirri*, the air flows spirally into an area of low pressure at the surface of the earth, and to some extent out

* "Reduction and Discussion of the Deviations of the Compass," by Fred. J. Evans, Esq., R.N. Philos. Trans. 1860, part ii., pp. 334—358.

from it in the upper regions of the air; whilst the order is reversed with areas of high pressure, the lower air flowing *out from*, and the upper air *in towards*, their centres. It remains to be proved whether the same law holds good with regard to the area of high pressure in the centre of the Atlantic. . . . It must be remembered that there are upper currents of air which (owing to the absence of moisture) do not carry clouds along with them, and that they need some other means than cloud motion to detect them."—*Captain Henry Toynbee.*

Mr. Ley also considers that the classification of the late Mr. Luke Howard, which has been in use for sixty years, is not suitable for present state of weather knowledge. Without materially altering the old nomenclature, Mr. Ley is of opinion that the clouds may be divided into Upper and Lower clouds, or those high in the atmosphere, such as *cirrus*, *cirro-cumulus*, and *cirro-stratus*, and those nearer the earth's surface, including *Stratus*, *Cumulus*, *Cumulo-stratus*, and *Nimbus*.*

Clouds are seen at all levels between the highest *cirrus* and the lowest *stratus*, so that it is often difficult to determine whether a particular sheet or layer of cloud belongs to the upper or the lower system. In such cases the observer will be greatly assisted by remembering how the clouds have become formed, whether by the gradual subsidence of the highest forms, or by the ascent of the lower clouds.

In the Trade Wind region, by observing the direction of the upper clouds, it would appear that an opinion may be formed of the probable direction of the squalls in unsettled weather, as remarked (p. 285) by Capt. Toynbee.

The Upper Clouds are considered a good authority to be composed of particles of ice, inasmuch as the phenomena of halos, &c., are produced by them, and these can only be explained by the refraction of the rays of light through ice crystals.

The *Cirrus* is often seen after a continuance of fine light weather, as a fine whitish line of cloud, stretched across the sky at a great height, the ends seeming lost in the horizon. This is often the first indication of a change to wet weather; to this line of Cirrus others are added laterally, and at times clouds of the same sort seem to proceed from the sides of the line, and are sent off in an oblique or transverse direction, so that the whole may have the appearance of net-work.

At other times the lines of Cirrus become denser, descend lower in the atmosphere, and, by uniting or conjoining with others below, produce rain. The line alluded to above is called the *Linear Cirrus*, and the transverse lines produce the *Reticulated* or *Curl Cloud.*

The *Comoid* or *Hairy Cirrus*, commonly called *Mare's Tail*, is the proper Cirrus; it resembles, in appearance, a long lock of white hair, or a bunch of wool pulled out into fine pointed ends. The appearance of Cirrus in the atmosphere often indicates wind and rain; and when the fine tails have a constant direction toward any one point of the compass, it has been fre-

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* In abbreviating these names the following system is used by the Meteorological Office, as others have been found to mislead: —Cir.; Cir. c.; Cir. s.; Str.; Cum.; Cum. s.; Nim. The amount of cloud is registered from 0 "Blue sky;" to 10 "Entirely overcast."

quently observed that the gale has sprung up from that quarter to which they previously pointed. It is often difficult to ascertain the direction of the *Cirrus*, owing to its slowness of motion, but as indicating the difference between the direction of the wind at the earth's surface, and that of the higher regions, it is very important.

The Lower Clouds are usually composed of particles of condensed vapour or "bubble-steam," i.e., of water, not of ice, when they are interposed between the sun and the moon, they dim or intercept the light entirely, without giving rise to *halos* or *coronæ*. They may be described as follows:—

The *Cirro-cumulus* (cirrus and cumulus) is an assemblage of *nubeculæ*, or small roundish clouds, either detached form, or in contact with, each other, and frequently reaching, to appearance, into the azure sky, commonly attended by an increased temperature, and found to accord with a rising barometer. The most striking feature is observed in summer, before or about the time of thunder-storms. The component nubeculæ are then very dense, round in form, and in closer apposition than usual. This kind of cloud is so commonly a forerunner of storms, that it has been assumed by some as a tempestuous prognostic. In rainy and variable weather another variety of this cloud appears, contrasted very strikingly with that above mentioned, being of a light fleecy texture, without any regular form in its nubeculæ. Sometimes the latter are so small as scarcely to be discernible, but the sky seems speckled with innumerable little white transparent spots.

The Cirro-cumulus of fair summer weather is of a medium nature, not so dense as the stormy variety, nor so light as the variable one. Its nubeculæ vary in size and proximity. In fine dry weather, the light gales of North and easterly winds, small detachments rapidly form and subside again, generally in an horizontal arrangement.

When the Cirro-cumulus prevails, we may anticipate an increase of temperature in summer; and in winter the breaking up of a frost, or warmer and wet weather. In the summer time, extensive beds of this cloud, viewed by moonlight, have a very beautiful appearance, which has been compared to a flock of sheep at rest. The Cirro-cumulus subsides either slowly, as if by evaporation, or changes into some other modification.

The *Cirro-stratus* (cirrus and stratus) or *Wane Cloud*, is composed of horizontal or slightly inclined masses of small clouds, attenuated toward a part or the whole of their exterior, bent downward or undulated, separate or in groups, and generally with a sinking barometer, indicating a decrease in temperature, with wind and rain or snow.

The Cirro-stratus is characterised by great horizontal extent in proportion to vertical breadth; so that when any other cloud begins to assume that form, it generally ends in Cirro-stratus. The Cirrus more commonly becomes a Cirro-stratus than any other cloud; the Cirro-cumulus next; and then the Cumulus. The Cirri-stratus, once formed, sometimes resumes the modification from which it originated, but more frequently it gradually evaporates or conjoins with some other modification. It seldom remains long in one form, but seems to be constantly declining, and hence the term of *Wane Cloud*. It is sometimes composed of wavy bars or streaks, connected in the centre and confused, but the streaks more defined at the edges; this is common in variable weather in summer. The *Mackerel Sky*, as it is

termed, is a variety of this; another variety consists of one long and plain streak, thick in the middle, and wasting away at its edges; and a third, consisting of small rows of little clouds, curved in a peculiar manner, and a sure indication of stormy weather; this is more or less regularly formed, and the irregular formation is often produced when a large Cumulus passes under a long line of Cirro-stratus, and is also a sign of stormy weather.

The last variety of Cirro-stratus is a large shallow veil of cloud, which extensively overspreads the sky, particularly in the evening and during the night, and through which the sun and moon appear dimly. It is in this cloud that those peculiar refractions of light, of the sun and moon, called *halos*, *mock suns*, &c., usually appear, and which is a tolerably certain prognostic of rain or snow. There are minor varieties which may frequently be observed.

The Cirro-stratus usually terminates in forming an intimate union with some other cloud, to produce rain; but at times it evaporates or changes into some other modification.

The *Stratus* comprehends fogs and all those creeping mists which in summer evenings fill the valleys, but disappear in the mornings. The best time for observing its formation is on a fine evening, after a hot summer's day; we shall then observe that, as the Cumuli of the day decrease, a white mist forms near the ground; this cloud, as the Cumuli evaporate, by degrees arrives at its density. In autumn it remains longer in the morning. In winter it often puts on a still denser appearance, and remains during the day, and even for many days successively.

The *Nimbus* always precedes a fall of snow, rain, or hail; and has received its name from a notion of the ancients, who distinguished between the *Imber*, or shower, and the *Nimbus*, or cloud, from which the rain comes.

The *Cumulus* (plural, *Cumuli*). The progressive formation of the Cumulus is seen in fine settled weather. If we then observe the sky soon after sun-rise, we shall see small clouds here and there in the atmoshere, which appear to be the result of small gatherings, or concentrated parts of the evening mist, which, rising in the morning, grow into small masses of cloud, and the atmosphere becomes clear. As the sun rises, these clouds become larger, by adjacent ones coalescing, and at length a large cloud is formed, assuming a cumulated irregular hemispherical shape; this usually subsides in the evening as it is formed in the morning, breaking into small masses, then fragments, and evaporating, when it is succeeded by the Stratus, to the formation of which it may have contributed. In fine weather these clouds form soon after sun-rise, increase during the day, and subside with more regularity, and have a more hemispherical form than in changeable weather. When well-formed Cumuli prevail for three or four days, the weather is settled. These Cumuli reflect a strong silvery light when opposed to the sun, like Alpine mountains covered with snow.

The cumulus sometimes take a cylindrical shape, forming itself into long horizontal rolls, between which gleams of light are seen, but which are often so closely packed as to hide the blue sky. These are called *Roll-cumulus*. This variety of cumulus is an addition to Howard's nomenclature. It is inserted owing to the frequency of this appearance at sea. It is necessary to observe that the effect is simply one of perspective.

The *Cumulo-stratus* designates the Cirro-stratus blended with the Cumulus, and either appearing intermixed with the heaps of the latter, or superadding a wide structure to its base. The Cumulo-stratus is most frequent during a mean or changeable state of the barometer, when the wind blows from the West, with occasional deviations from the North and South.

This cloud may be always regarded as a preliminary to the production of rain; and it frequently forms in the following manner:—the Cumulus, which in common passes along in the current of the wind, seems retarded in its progress, increases its density, spreads out laterally, and at length overhangs the base, in dark and irregular protuberances. The change to the Cumulo-stratus often takes place at once in all the Camuli which are near to each other; and their bases uniting, the superstructure rises up with mountain-like or rocky summits. The change from Cumulus to Cumulo-stratus is often preceded by Cirro-stratus.

Cumulo-strata vary in appearance; those in which hail showers and thunder storms form look extremely black before the change to rain, and have a menacing aspect, as they are seen coming slowly up with the wind. The Cumulo-stratus sometimes evaporates or changes again into cumulus; but in general it ends in the Nimbus and fall of rain or snow. Sometimes only one part forms a Nimbus, the other remaining a Cumulo-stratus.

General Remarks on the *Nimbus*.—Any of the modifications above described may increase so much as to obscure the sky, without ending in rain; before which the peculiar characteristic of the rain-cloud may always be distinguished. In order to get a clear idea of its formation, you may observe a distinct shower in profile, from its formation to its fall in rain, You may then observe the Cumulus first arrested, then the Cirro-stratus or Cirrus may appear to alight on its top; the change to Cumulo-stratus then goes on rapidly, and this cloud, increasing in density, assumes that black and threatening appearance known as an indication of rain: presently this blackness is changed to a grey obscurity, and this is the criterion of the actual formation of water, which now begins to fall, and constitutes the cloud a *Nimbus*, while a Cirriform crown of fibres extends from the upper part of the clouds, and small Cumuli enter into the lower part. After the shower has spent itself, the cloud resumes its title of Cumulo-stratus, and thence probably changes into a different modification; and if Cumulo-strati appear again, they indicate a return to rain.

As connected with this subject, the indications of a change of weather, we annex a description of SQUALLS, from the work of the distinguished navigator to whom we are indebted for the leading paragraphs of the present section.

"Squalls are generally of *three* kinds: that called the *Arched Squall* is frequently experienced, and usually rises from the horizon in the form of an arch; but sometimes it assumes the appearance of a dense dark cloud, particularly when highly charged with rain, or electric matter. From the time that the arch or cloud is first seen above the horizon, its motion is

sometimes very quick to the zenith, the interval being scarcely sufficient to allow a ship to reduce the necessary sail before the wind reaches her, which happens when the cloud has approached the zenith. At other times the motion of the cloud is very slow, and not unfrequently it disappears, or is dispersed, the impulse of the wind being not then sufficient to reach a ship. As a general rule, it may be observed, that if there be rain in these squalls preceding the wind, the latter will probably follow the rain in sudden severe gusts; whereas if the wind precedes the rain, the squalls are seldom so furious, and terminate in moderate showers of rain. The general rule, however, is often interrupted by the operation of local causes.

"The *Descending Squall* is not so easily discerned as the former, because it issues from clouds which are formed in the lower parts of the atmosphere, near the observer; and when clouds are thus formed, they generally produce showers of rain, and successive squalls of wind.*

"The *White Squall* is not often experienced; but it sometimes happens near to, or within, the tropics, particularly in the vicinity of mountainous land. This squall generally blows very violently for a short time; and, as it is liable to happen when the weather is clear, without any appearance in the atmosphere to indicate its approach, it is consequently very dangerous. The only mark that accompanies it is the wind.

Captain FitzRoy says:—"Undoubtedly the worst wind, next to a hurricane, which a vessel can encounter, is a violent *White Squall*, so called because it is accompanied by no cloud or peculiar appearance in the sky, and because of its tearing up the surface of the sea, and sweeping it along so as to make a white sheet of foam. By squalls of this description, frequent in the West Indies, and occasionally felt in other parts of the world, no notice will be given much above the horizon; but, by consulting a good barometer or simpiesometer, and frequently watching the surface of the sea itself, even a white squall may be guarded against in sufficient time.

"Dark clouds, hard mixed with soft, and inky fragments in rapid motion beneath them, accompanied, perhaps, by lightning and distant thunder, are the forerunners of a heavy squall. Soft shapeless clouds, in which it is impossible to point out a definite edge, usually bring rain, but not wind; and, generally speaking, the more distinctly defined the edges of the clouds are, the more wind they foretell. A little attention to these simple observations, so familar to persons who have been some time at sea, may save young officers unnecessary anxiety in one case, and prompt them to shorten sail at a proper time in the other."—("Voyage of the *Beagle*," vol. ii. p. 49.)

Some further remarks on White Squalls are given in page 285.

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* In the Mexican Sea heavy and very sudden descending squalls come up at times from very small clouds. These are scarcely felt until the cloud is almost right over the ship's masts.—*A. L.*

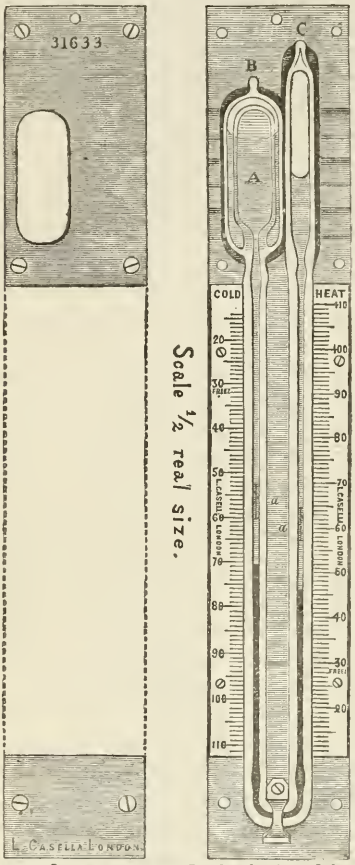
MARINE THERMOMETERS.

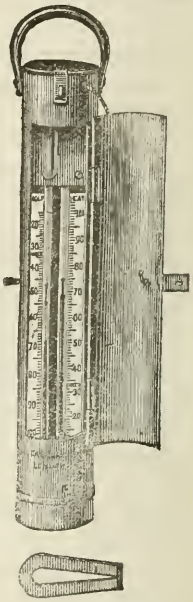
Deep Sea Thermometers.—The following is from the pen of Dr. J. J. Wild, Member of the Scientific Staff of H.M.S. *Challenger*, and appears in his valuable work "Thalassa," an Essay on the Depth, Temperature, and Currents of the Ocean:—"The want of an efficient deep-sea thermometer, which more or less vitiates all the observations of earlier explorers, was especially experienced during the cruise of H.M.S. *Lightning* in 1868, the first expedition fitted out for sounding and dredging purposes by the joint co-operation of the Royal Society and the Admiralty of England. Of the thermometers used on this occasion, several returned to the surface broken by the pressure to which they had been exposed, and the indications given by the rest varied so much as to render the discovery of a thermometer free from this error a matter of paramount importance for the success of future deep-sea exploration. By a happy coincidence, the desired improvement was effected at the moment when a second expedition was being prepared. In April, 1869, previous to the departure of H.M.S. *Porcupine* on her first cruise, at a meeting of the Deep-sea Committee of the Royal Society of London, Dr. W. A. Miller, V.P.R.S., suggested a simple expedient for protecting thermometers from the effects of pressure, which, ably carried out by Mr. L. P. Casella, F.R.A.S., the eminent scientific instrument maker to the Admiralty, resulted in the construction of an almost perfect instrument for recording the temperature at great depths. One of the essential qualities of an instrument intended for use on long voyages is that it should be portable—a quality especially realised by Mr. Casella in the construction of his thermometer. By contracting the bore of the glass tube as much as possible, the quantity of the liquids, particularly of the mercury, has been reduced to a minimum; and the liability to accident, almost inseparable from instruments containing large quantities of this heavy substance, has thus been greatly reduced.

"The cruise of H.M.S. *Challenger* afforded ample opportunities for testing the capabilities of the Miller-Casella thermometer. It resisted all the pressures to which it was exposed down to a depth of about 4,000 fathoms, when some of the instruments were found to give way under a pressure of four tons to the square inch; but as depths of from 4 to 5 miles are exceptional, such accidents will be of rare occurrence. Under a pressure of three tons, equivalent to a depth of 3 miles, the error amounts to less than 1° C, whilst that of the unprotected thermometers previously in use sometimes exceeded 10° C for the same depth; and a comparison of the data furnished by the Miller-Casella thermometer with the corresponding temperature curves shows that the mean error of all the deep-sea observations made on board H.M.S. *Challenger*, not much under 10,000, is probably less than 0·5° C. The thermometers, before being sent out, are subjected to pressures varying from one to four tons to the square inch in a hydraulic press especially designed for this purpose by Mr. Casella, and the amount of error ascertained for each instrument. When in actual use, they are enclosed in a copper cylinder perforated at both ends to allow free ingress and egress of the water. Several thermometers may be attached to the same sounding-line whilst it is being paid out, at distances of 5, 10, 25, 50, or 100 fathoms as required; and it is found that an immersion of from five to ten minutes is sufficient to secure the desired record of temperature. Since all the observations made on board H.M.S. *Challenger*, during her cruise round the world, were obtained, and

the true temperature of the sea been determined by means of this instrument, now known as the Miller-Casella thermometer, a description of it in these pages may not be out of place.

"The Miller-Casella Thermometer.—It will be seen from the accompanying figure that this thermometer is designed to register the maximum and minimum temperature of the water to which it is exposed during its descent from the surface of the sea to the bottom. For this purpose the glass tube is bent in the shape of U, each arm of the tube terminating in a bulb. The larger bulb, A, is surrounded by another bulb, B, and about three-fourths of the space between the two bulbs is filled with alcohol. It is by the addition of this outer bulb, B, that the protection of the instrument from the effects of pressure is secured. On immersion, the outer bulb receives the pressure of the water, and forces the enclosed alcohol into the portion of the intervening space previously not occupied by this liquid, thus relieving the inner bulb, A. The latter is completely filled with a mixture of creosote and alcohol, which rests upon the mercury contained in the bend of the tube, and also fills up the other arm and part of the bulb C. The upper part of bulb C is occupied by air, introduced, with the help of a freezing mixture, at a very low temperature, in order to increase its elastic force. It thus acts as a sort of elastic spring or cushion intended to overcome the weight and friction of the mercury in the tube, and to assist the mercury in following the mixture when contracting under the influence of cold. The indications of the thermometer depend upon the expansion by heat and contraction by cold of the mixture contained in bulb A. When expanding, the mercury is forced down in the arm attached to this bulb and rises in the other arm towards bulb C; when contracting, the mercury falls on the side of bulb C, and rises towards bulb A. Two steel indices, *a a*, covered with glass, mark the maximum height which the mercury has reached in either arm, and a hair attached to each index produces the friction necessary to retain them at the level to which they have been raised. Before the thermometer is lowered into the sea, the indices are brought down upon the mercury by passing a magnet along the tube.

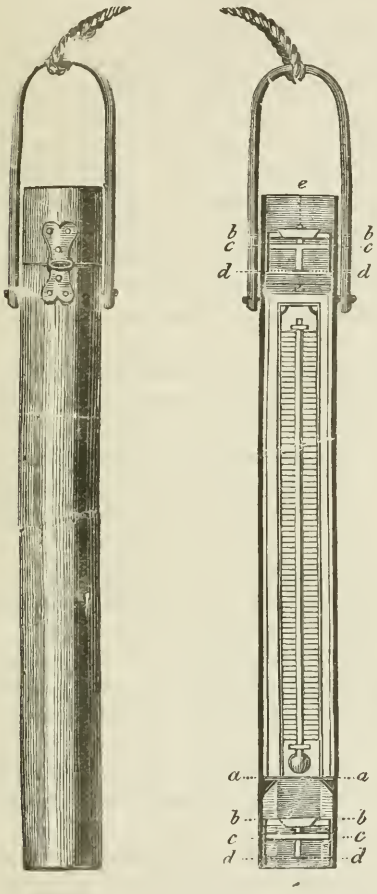




Miller-Casella Thermometer, in case.

The following illustration has appeared in many previous editions of this work, and, although the instrument is old-fashioned, its principle is good for small depth observations, such as those required by fishermen.

Capt. Livingston says:—"In my thermometric experiments I had several thermometers broken, and I have heard objections made to the experiments, that, in the manner they were made, the thermometer was not immersed far enough to enter into water sufficiently uninfluenced by the heat of the solar rays; but it will be seen, by comparing the day and night observations, that this is a futile objection. However, to avoid it, to secure my thermometers from being broken, and to enable me to have a column of water round the thermometer, sufficient to retain its original temperature till such time as the degree indicated by the thermometer scale could be read off, keeping at the same time the bulb of the thermometer immersed in the water. I prevailed on an ingenious mechanic to attempt the structure of such a case as I wanted, in which he has most happily succeeded."



The person here alluded to is Mr. Robert Jamieson, of Glasgow, who was honoured with the large silver medal of the Society for the encouragement of Arts.

Description. — The first figure, hereto annexed, represents the case, a tube of copper, which encloses a thermometer; the second figure represents a thermometer, so enclosed. The length of the whole tube, including the lid, is about 18 inches, and its external diameter 2 inches. The lid, which has a check to fit the tube, is about 2 inches deep, and has a conical or puppet valve in it, which rises upward. At the lower end of the tube is another valve of the same description, which also rises upward; and these two valves permit the water to pass freely through the tube while it descends into the water; but so soon as it stops, the valves shut, and the water, admitted at the greatest depth to which the machine is sunk, remains in the tube, around the thermometer.

Fig. I. is a back view of the case ready for use. In fig. II. *a a* represents a ring, or collar, on which the thermometer-plate rests, to keep it clear of the lower valve; *b b*, the upper valve and valve-tube cover; *c c*, a bridge on which the neck rod, or journal, of the valve works, through a hole in a swell in the centre of the bridge; *d d*, lower part of the journal, with a screw-head, which keeps it from rising through the hole in the bridge; *e e*, ends of the journals.

REMARKS ON THE BAROMETER.

*By the late Admiral FitzRoy, F.R.S.**

The words on scales of barometers should not be so much regarded for weather indications, as the rising or falling of the mercury; for if it stand at *Changeable*, and then rise towards *Fair*, it presages a change of wind or weather, though not so great as if the mercury had risen higher; and, on the contrary, if the mercury stand above *Fair* and then fall, it presages a change, though not to so great a degree as if it had stood lower; besides which, the direction and force of wind are not in any way noticed. It is not from the point at which the mercury may stand that we are alone to form a judgment of the state of the weather, but from its *rising* or *falling;* and from the movements of immediately preceding days as well as hours, keeping in mind effects of change of *direction*, and dryness, or moisture, as well as alteration of force or strength of wind.

In western Europe, towards the higher latitudes, the quicksilver ranges, or rises and falls, nearly three inches—namely, between about thirty inches and eight-tenths (30·8), and less than twenty-eight inches (28·0) on extraordinary occasions; but the usual range is from about thirty inches and a half (30·5) to about twenty-nine inches. Near the Line, or in equatorial places, the range is but a few tenths, except in storms, when it sometimes falls to twenty-seven inches.

The sliding-scale (vernier) divides the tenths into ten parts each, or hundredths of an inch. The number of divisions on the vernier exceeds that in an equal space of the fixed scale by one.

If the barometer has been about its ordinary height, say near thirty inches, at the sea level,† and is steady, or rising—while the thermometer fall, and dampness becomes less—north-westerly, northerly, or north-easterly wind—or less wind—may be expected.

On the contrary, if a fall takes place, with a rising thermometer and increased dampness, wind and rain (or snow) may be expected from the south-eastward, southward, or south-westward.

Exceptions to these rules occur when a north-easterly wind, with wet (rain or snow) is impending, before which the barometer often rises (on account of the *direction* of the coming wind alone), and deceives persons who, from that sign only, expect fair weather.

When the barometer is rather below its ordinary height, say, near twenty-nine inches and a half (at the sea level *only*), a rise foretells less wind, or a change in its direction toward the northward—or less wet; but when the

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* It must be remembered that these remarks were written previous to the discovery of the cyclonic and anti-cyclonic systems of storms (p. 249), which cross our islands. They are, however, quite in agreement with the newly-discovered systems.

† It stands lower, about a tenth of an inch for each hundred feet of height directly upwards, or vertically, above the sea, where its average height, in England, is 29·94 inches (at 32° F.).

mercury* has been low, say near twenty-nine inches—the first rising usually precedes and foretells, strong wind—(at times heavy squalls)—from the north-westward—northward—or north-eastward—*after* which violence a rising glass foretells improving weather, if the thermometer falls. But, if the warmth continue, probably the wind will back (shift against the sun's course), and more southerly, or south-westerly wind will follow.

The most dangerous shifts of wind, and the heaviest northerly† gales, happen after the mercury first rises from a very low point.

Indications of approaching changes of weather, and the direction and force of winds, are shown less by the height of mercury in the tube, than by its falling or rising. Nevertheless, a height of about thirty inches (at the level of the sea) is indicative of fine weather and moderate winds.

The barometer is said to be *falling* when the mercury in the tube is sinking, at which time its upper surface is *sometimes* concave or hollow. The barometer is *rising* when the mercurial column is lengthening; its upper surface being then, as usual, convex or rounded.‡

A rapid rise of the barometer indicates unsettled weater. A slow rise, or steadiness, with dryness, shows fair weather.

A considerable and rapid fall is a sign of stormy weather and rain. Alternate rising and sinking show very unsettled weather.

The greatest depressions of the barometer are with gales from the S.E., southward, or S.W.; the greatest elevations, with winds from the N.W., northward, or N.E.

Although the barometer generally falls with a southerly and rises with a northerly wind, the contrary *sometimes* occurs; in which cases the southerly wind is dry and the weather fine; or the northerly wind is wet and violent.

When the barometer sinks considerably, high wind, rain, or snow will follow; the wind will be from the northward, if the thermometer is low (for the season)—from the southward if the thermometer is high.

Sudden falls of the barometer, with a westerly wind, are sometimes followed by violent storms from N.W. or North.

If a gale sets in from the eastward or S.E., and the wind veers by the South, the barometer will continue falling until the wind becomes S.W., when a comparative lull may occur, after which the gale will be renewed; and the shifting of the wind towards the N.W. will be indicated by a fall of the thermometer as well as a rise of the barometer.

Three things appear to affect the mercury in a barometer:—

1. The direction of the wind—the north-east wind tending to raise it most—the south-west to lower it the most, and wind from points of the compass between them proportionally as they are nearer one or the other extreme point.

N.E. and S.W. may therefore be called the wind's extreme bearing.

The range, or difference of height of the mercury, due to change of direc-

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* In an Aneroid, a metallic, or a wheel barometer, the hands' motion should correspond to that of the mercury in an independent instrument.

† Southerly in South latitude.

‡ In the best columns, those of standards for example, no concavity is seen at any time.

tion only, from one of these bearings to the other (supposing strength or force, and moisture, to remain the same) amounts in these latitudes to about half an inch (shown by the barometer as read off).

2. The amount, taken by itself, of vapour, moisture, wet, rain, or snow, in the wind or current of air (direction and strength remaining the same), seems to cause a change amounting, in an extreme case, to about half an inch.

3. The strength or force alone of wind from any quarter (moisture and direction being unchanged) is preceded or foretold by a fall or rise, according as the strength will be greater or less, ranging in extreme cases to more than two inches.

Hence, supposing the three causes to act together—in extreme cases—the mercury might range from about 31 (30·8) inches to near 27 (27·1) inches, which has happened occasionally.

Generally, however, as the three act much less strongly, and are less in accord, ordinary varieties of weather (the wind varying between S.W. and N.W., with more or less cloudiness or rain) occur much more frequently than extreme changes.

Another general rule requires attention; which is, that the wind usually veers, shifts, or goes round *with the sun* (right-handed in the northern places, left-handed in the southern parts of the world), and that, when it does not do so, or backs, more wind or bad weather may be expected instead of improvement.

In a barometer the mercury begins to rise occasionally before the conclusion of a gale, sometimes even at its commencement, as the equilibrium of the atmosphere begins to be restored. Although the mercury falls lowest before high winds, it frequently sinks considerably before heavy rain. The barometer falls, but *not always*, on the approach of thunder and lightning, or when the atmosphere is highly charged with electricity.* Before and during the earlier part of serene and settled weather, the mercury commonly stands high, and is stationary.

Instances of fine weather, with a low glass, occur exceptionally, but they are always preludes to a duration of wind or rain, *if not both*.

After very warm and calm weather, rain or a storm is likely to occur; or at any time when the atmosphere has been *heated* much above the usual temperature of the season.

Allowance should invariably be made for the previous state of the column during some days, as well as hours, because its indications may be affected by remote causes, or by changes close at hand. Some of these changes may occur at a greater or less distance, influencing neighbouring regions, but not visible to each observer whose barometer feels their effect.

There may be heavy rains or violent winds beyond the horizon, and the view of an observer, by which his instruments may be affected considerably, though no particular change of weather occurs in his immediate vicinity.

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* Thunder clouds sometimes rise and spread against the wind (lower current). It is probable that there is a meeting, if not a conflict of air currents, electrically different, whenever lightning is seen. Their meeting, when the new one advances from the *polar* region, does not affect the barometer, except in oscillation, which is very remarkable at the time.

It may be repeated, that the longer a change of wind or weather is foretold by the barometer before it takes place, the longer the presaged weather will last; and, conversely, the shorter the warning, the less time, whatever causes the warning, whether wind or a fall of rain or snow, will continue.

Sometimes severe weather from an equatorial direction, not lasting long, may cause no great fall of the barometer, because followed by a *duration* of wind from polar regions; and at times it may fall considerably with polar winds and fine weather, apparently against these rules, because a *continuance* of equatorial wind is about to follow. By such changes as these one may be misled, and calamity may be the consequence if not thus forewarned.

This ends Admiral Fitzroy's remarks: what follows is taken chiefly from "Instructions in the use of Meteorological Instruments" issued by the Meteorological Office.

Further Remarks.—The barometer now recommended by the Meteorological Office for use at sea, is known as the Kew Marine Barometer. Each of these instruments is tested at the Kew Observatory, and the scales correctly marked, the errors due to the capacity of the cisterns, varying size of the tube, &c., having been allowed for. By means of the *Vernier*, the height of the mercurial columns may be read to a thousandth of an inch. For the prevention of *pumping* or oscillation of the column of mercury the lower part of the tube has a contracted bore down to the cistern, and the upper part as far as the scale portion is, of even a finer bore. In the larger bore, between these two fine bores, there is inserted a *pipette*, or funnel, spout downwards, the object of this being to intercept any air which, creeping up the sides of the tube, would, by getting into the vacuum at the top of the tube, completely upset the working of the instrument. The best test for moisture or for particles of air between the column of mercury, and the side of the glass tube is the magnifying glass by means of which the existence of such matter is easily detected.

Sometimes, though very rarely, a particle of dirt, or a bubble of air lodges in the very fine contraction of the tube of a marine barometer, and completely stops the action of the instrument. Whenever, therefore, a marine barometer becomes stationary or inactive when it evidently ought to be moving under the influence of atmospheric changes, there being no evidence of fracture of the glass, the cause may be surmised to be of this nature. It should then be taken down, the mercury allowed to fill the tube, and the instrument put aside, in an *inverted* position, for a few hours. On replacing it, the cause of the stoppage will generally be found to have been removed to a part of the tube where it can do no harm.

Barometers when in use at sea are slung in gimbals, and suspended from arms at least a foot long, so as to be perfectly free to assume the vertical position under every movement of the ship, and at the same time to keep clear of the bulkhead against which the arm is fastened.

Care should be taken that no readings from a barometer which is not hanging truly vertically should ever be recorded. Such readings will always be too high in proportion to the degree of obliquity.

At Kew, all Marine Barometers are rejected of which the index error at the ordinary pressure is greater than 0·015 inch, or the capacity error

greater than 0·004 inch, or for which the mercury takes less than 3, or more than 6, minutes to fall from the height of 1·5 inches, to that of 0·5 inch above the present pressure. This latter condition is to ensure the efficiency of the contraction as a provision against "pumping," as well as to prevent the danger of the barometer being too sluggish from over contraction.

Correction for Temperature, or reduction to 32° Fahr.—When the barometer is at a temperature below 32°, the correction is (+), *i.e.* to be added, and when it is above 32° it is (—), *i.e.* to be subtracted. Thus supposing the mercury in the barometer tube to stand at 28.5 inches, and the attached thermometer registers the temperature of the tube and case (not of the surrounding air) as 50°, the corrections, according to the following scale, of ·055 inch, must be subtracted from 28·5 inches, to reduce the reading to the standard temperature of 32°. Brass is considered the most suitable metal for barometer cases.

Correction to be applied to Barometers with Brass Scales, extending from the Cistern to the top of the Mercurial Column, to reduce the observation to 32° *Fahrenheit.*

Temperature.	INCHES.															Temperature.
	24·0	24·5	25·0	25·5	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
°	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	°
0	·061	·063	·064	·065	·067	·068	·069	·071	·072	·073	·074	·076	·077	·078	·080	0
10	·040	·041	·042	·042	·043	.044	·045	·046	·047	·047	·048	·049	·050	·051	·052	10
20	.018	·019	·019	·020	·020	·020	·021	·021	·021	·022	·022	·023	·023	·023	·024	20
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
30	.003	·003	·003	·004	·004	·004	·004	·004	·004	·004	004	·004	·004	·004	·004	30
40	·025	·025	·026	·026	·027	·027	·028	.028	·029	·029	·030	·030	·031	·031	·032	40
50	·046	.047	·048	·049	·050	·051	·052	·053	·054	·055	·056	·057	·058	·059	·060	50
60	·068	.069	·070	·072	·073	·075	·076	·077	·079	·080	·082	·083	·085	·086	·087	60
70	·089	·091	·093	·095	·096	·098	·100	·102	·104	·106	·108	·109	·111	·113	·115	70
80	·110	·113	·115	·117	·119	·122	·124	·126	·129	·131	·133	·136	·138	·140	·143	80
90	.131	·134	·137	·140	·142	.145	·148	·151	·153	·156	·159	·162	·164	·165	·170	90
100	·153	.156	·159	·162	·165	·169	·172	·175	·178	·181	·184	·188	·191	·194	·197	100

The Aneroid is an instrument which has come into extensive use, owing to its convenient size and portability. In the aneroid, atmospherical pressure is measured by its effect in altering the shape of a small, hermetically sealed, metallic box, from which almost all the air has been withdrawn, and which is kept from collapsing by a spring. The top of the box is corrugated.

When the atmospherical pressure rises above the amount which was recorded when the instrument was made, the top is forced inwards, and *vice versâ*, when pressure falls below that amount, the top is pulled outwards by the spring. These motions are transferred by a system of levers and springs to a hand which moves on a dial like that of a wheel barometer.

A most serious objection to the scientific utility of these instruments is their liability to injury, owing to rust or to the alteration of force in the springs used in their construction. However, for the reasons above stated, the aneroid is especially suitable for fishermen, pilots, or seafaring persons employed in boats or small coasting vessels, in which there is not space to suspend a barometer.

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